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THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION

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Original Communications

STUDIES ON THE ETIOLOGY OF ROOT CANAL INFECTIONS: THE NATURE OF THE CAUSATIVE AGENTS AND THEIR BEHAVIOR WITH RESPECT TO ELECTIVE LOCALIZATION IN RABBITS*

By U. G. RICKERT, M.A., D.D.S., CHALMERS J. LYONS, D.D.Sc., and FAITH PALMERLEE HADLEY, M.S., Ann Arbor, Michigan

WHATEVER one may come to believe regarding the normal sequence of occurrence of root canal and periapical infections, there exists a prevailing assumption that, in any given case, the microbes causing the one are also operative in the other, and that the infective process is continuous and progressive in one direction or the other.

This assumption seems logical; but, whether or not it is true, a careful survey of the literature that has grown up about this subject reveals the fact that nearly all efforts to gain a better understanding of the bacterial agents involved, and of the course of the infection, have been made through the use of culture methods designed to reveal the microbic flora of the periapical tissues, rather than of the pulp canals. The most common technic has been to extract the tooth with assumed proper aseptic precautions, and then to swab over the apical area. It is seldom that an attack has been made on this problem through the somewhat more laborious, but presumably safer, method of examining bacteriologically, or by stained preparations, the root canal contents.

That, in the hands of an expert and experienced worker, a tooth may be ex-

*The discussion of this paper will be found on page 1223.

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Sixty-Seventh Annual Session of the American Dental Association, Louisville, Ky., Sept. 23, 1925.

tracted and cultured by the former method and in such a manner as to avoid contamination of the apical area, or adjoined tissue fragments, with the organisms of the mouth is perhaps possible; but that this method has been successful in the hands of all investigators who have given reports on the nature and etiology of periapical infections is open to grave doubt.

The question therefore arises: To what extent, if at all, would the bacteriologic findings obtained by methods of culturing the root canal contents, after thorough sterilization of the apex of the tooth, compare with the results obtained from the direct culturing of the infected periapical tissue, as reported in recent literature? This is essentially the first problem to which our attention has been given during the past year, and one on which the present paper is the first report. It represents a continuation of earlier studies on the same subject, but involves the use of newer methods of approach to the purely bacteriologic aspects of the problem involved.

In addition, an attempt has been made, by the use of biochemical and serologic methods, to scrutinize more carefully the types of organisms present, and to relate them, as far as possible, according to the newer methods of classification, to well-known streptococcal residents of the mouth, throat or intestinal tract, and thus to gain greater insight into the origin of the infections, whether exogenous or hematogenous. And, finally, we have endeavored to ascertain to what extent, if at all, the microbes isolated from infected pulps of individuals presenting evidence of localized streptococcal or other infections possess the power of producing elective localizing lesions when injected into rabbits. Although the cases reported in this phase of the work are not large in numbers, we believe that they possess a significance which will become clearer as future work adds to the number in which clear cut case histories are available.

THE INFECTION OF PULPLESS TEETH AND OF VITAL TEETH WITH DEGENERATING PULP

Method of Culturing Teeth.—In culturing extracted teeth, the following method was used. The crown of the tooth was held firmly with sterile pliers and the root swabbed with tincture of iodin, which was allowed to remain for two or three minutes. The iodin was then swabbed off with alcohol and the tooth passed very quickly through the flame. When perfectly dry, the apex was snipped off with sterile bone cutters into a sterile glass container. The root canal was then entered with a sterile broach and any loose material withdrawn and placed in the culture medium (calves brain broth, p_H 7.6, to which 0.2 per cent sterile glucose is added). The crushed apex of the tooth was removed with sterile forceps from the glass container to the culture medium. If the root canal was so filled that it could not be entered with a broach, the apex only was used for culturing.

Percentage of Pulpless Teeth Infected.—Of seventy-four pulpless teeth cultured by the method described above, forty-three, or 58 per cent, gave positive cultures, and thirty-one, or 42 per cent, were negative. Most of these negative cultures were then subjected to different growth conditions, such as the addition of ascitic fluid or sterile rabbit serum, or by further reducing the oxygen tension by the use of the Buch-

ner pyrogallic acid method. In no case did growth appear even after incubating for three or four weeks. Some of these teeth undoubtedly possessed infections of the periapical tissue, which we missed through our method of culturing. It is our opinion, as based on other means of study, that, in these cases, the canals contained no organisms.

Of the forty-three teeth giving positive cultures, nineteen had canals containing no filling material, nine had poorly filled canals, and five were well filled. Of ten, we have no record. Of the thirty-one negative teeth, six had canals with no filling, nine were poorly filled, and seven well filled, and of nine we have no record. The number and percentage of instances in each group is shown in Table 1.

TABLE 1.—PERCENTAGE OF POSITIVE AND NEGATIVE PULPLESS TEETH CORRELATED WITH CONDITIONS OF PULP CHAMBER

	Total	No Filling	Poorly Filled	Well Filled	Condition Unknown
No. of teeth giving positive culture	43	19	9	5	10
	58%	76	50	41	53
No. of teeth giving negative culture	31	6	9	7	9
	42%	24	50	59	47

Percentage of Live Teeth Infected.—Of seventeen vital teeth with atrophied or degenerating pulps, ten, or 59 per cent, gave positive cultures, while seven, or 41 per cent, were negative.

Types of Organisms Present.—Of the forty-three pulpless teeth giving positive cultures, thirty showed pure cultures of streptococcus, and three showed mixed cultures of streptococcus and staphylococcus, together with a diphtheroid. Of the remaining ten, two gave pure cultures of *Staphylococcus albus* producing hemolysis on blood agar, one of *Staphylococcus albus* not hemolyzing blood; two showed pure cultures of *Bacterium mucosum-capsulatum* (Friedlander's bacillus or *bacterium pneumoniae*), and five gave pure cultures of unidentified rod forms, three of which were of the diphtheroid type and may have been a pleomorphic form of the streptococcus.

Of the ten live teeth giving positive cultures, nine were infected with streptococcus alone and one with *Staphylococcus albus*.

Twenty-six strains of streptococcus from dead pulps and five from live pulps were studied and grouped according to the classification of Andrewes and Horder, based on the fermentation of lactose, raffinose, inulin, salicin and mannite. All tests were made in a sugar-free beef infusion broth to which 1 per cent of the sterile carbohydrate and 1 per cent Audrade's indicator were added. Two drops of ascitic fluid were also added to insure growth. Of these thirty-one strains, thirty belonged to the viridans type and one to the hemolytic type of streptococcus. The latter grew in diplococcal form or short chains of four or six elements, and fermented lactose, salicin and mannite, thus corresponding to the morphologic and fer-

mentative characteristics of *S. fecalis*, although differing from it in its hemolytic capacity. *S. pyogenes*, the central type of the hemolytic streptococci, differs from this form not only in fermentative ability, but also in length of chain. We are inclined to believe that this hemolytic, mannite-fermenting diplococcus is a variant of *S. fecalis* rather than of *S. pyogenes*, but until we have carried out further tests, such as resistance to heat, we shall place it tentatively under the head of *S. hemolyticus*.

Of the thirty viridans strains, fifteen, or 50 per cent, were *S. fecalis*, ten, or 33 per cent, were *S. salivarius*, and five, or 17 per cent, were *S. mitis*. The relation of these types to the disease process found in patients is shown in Table 2. All of the cultures mentioned in this table were obtained by the method previously described and give the results on forty-one teeth from thirty-two cases.[1]

In this table, it is shown that, of all the types of streptococci found, *S. fecalis* was the most frequent in pulpless teeth.

TABLE 2.—RELATION BETWEEN TYPE OF ORGANISM PRESENT IN INFECTED PULPLESS AND VITAL TEETH, AND TYPE OF DISEASE PROCESS IN PATIENT.

Type of Culture	Pulpless teeth	Live Teeth with Degenerative pulps	Associated symptoms (times found)				
			Rheumatic	Gastro-intestinal	Cardiac	Nephritic	Iritic
S. fecalis	15	0	6	1	0	0	0
S. salivarius	7	3	3	0	3	1	1
S. mitis	3	2	2	0	0	1	0
S. hemolyticus	1	0	1	0	0	0	0
Staphylococcus	5	1	3	1	1	0	1
Pneumobacillus	2	0	0	2	0	0	0
Rod forms not Identified	8	0	4	0	2	0	0

These results are in harmony with the work of Kritchevsky,[2] who also cul-

1. When several teeth were extracted from the same patient it was interesting to note whether the types of organism in all teeth were the same. Three teeth extracted from one patient at different times gave pure cultures of *S. fecalis* in every instance. Of three teeth from another patient, two gave *S. fecalis* and one gave *S. mitis*. Another patient showed in two different teeth *S. fecalis* and *Bacterium mucosum-capsulatum*. From a fourth patient were extracted two teeth, both of which showed *S. fecalis*. Still another had one tooth infected with *S. salivarius* and another with *Staphylococus albus*. Thus, it appears that, in some cases, one organism is responsible for the infection of different teeth in one individual; while, in other cases, two or more different types are present.

2. Kritchevsky, B.: Dent. Magazine, 41: 703, 1924.

tured the pulp chamber (although with slightly different technic) and with the findings of Price,[3] who fails to state the nature of his method. They are at variance with the results of most investigators, who, like Broderick[4] and Fraser,[5] give results on the cultivation from periapical tissues. In most instances, it is *S. salivarius* that is found with greatest frequency. In our cases, *S. salivarius* took second place and *S. mitis* third. Whereas both *S. salivarius* and *S. mitis* were found in live teeth showing pulp degeneration, we found no *S. fecalis* strains in these cases.

The significance of our finding *S. fecalis* as the chief infecting agent in pulpless teeth is not clear, nor are any far-reaching conclusions attempted on the limited evidence, but the data, superficially considered, suggest that one of two things might be true: either (1) pulp infections in general are not determined by the same form of streptococcus that is most common in periapical infections, or (2) the many instances of periapical infection in which *S. salivarius* has been found as the predominating agent are supported by the circumstance of frequent contaminations arising from *S. salivarius* of the mouth at the time that the tooth was extracted and the culture taken. The predominating *S. fecalis* type of infection would, moreover, suggest a hematogenous origin, as this is the type of streptococcus most often found in the intestines, but seldom encountered in the mouth.

One other point may eventually be found to bear on these cases: the possibility of distinct mutations in the streptococcus type subsequent to the time of infection and consequent to progressive changes in environment occurring in the pulp chamber. This possibility will receive further discussion.

3. Price, W. A.: I. Dental Infections, Oral and Systemic, p. 57.

4. Broderick, R. A.: Brit. Dent. J., 46: 357, 1925.

5. Fraser, C. J.: Dominion Dent. J., 36: 170, 1924.

EXPERIMENTAL EVIDENCE OF ELECTIVE LOCALIZATION OF BACTERIA FROM ROOT CANALS

In the majority of the thirty-two cases mentioned above in connection with Table 2, the case history was lacking. In eleven instances, a more or less complete history of the case was available, and these, which are naturally of particular interest, are presented, together with the bacteriologic findings, in the following paragraphs.

Report of Cases

Case 1.—A woman, aged 45, had had a paralytic stroke and was slowly losing her eyesight. Two of three teeth sent to us for culturing were negative. The third tooth, the root canal of which had never been entered, was found to be vital but perfectly dry, in the bullous portion, and gave a growth of a hemolytic staphylococcus.

Animal Inoculations.—One young rabbit was injected with 3 c.c. of the hemolytic staphylococcus. Eighteen hours after injection, the cornea of each eye was severely inflamed, and the blood vessels of the iris greatly distended. Twenty-eight hours after injection, the eyes showed a profuse white discharge and the fore legs of the rabbit were paralyzed. One hour later, the animal died. Necropsy was performed immediately. Small dewdrop-like lesions covered the liver, the lungs were congested and the thymus and mesenteric glands showed punctiform hemorrhages. Other organs appeared normal. Unfortunately, the nervous system was not examined. Cultures from the eye discharge, liver and lungs gave growths of the hemolytic staphylococcus, but blood culture was negative.

A second rabbit was given 3 c.c. of the hemolytic staphylococcus from the eye of the first rabbit and a third was given an injection

of the lung culture. The second rabbit was not affected in any way, but the third died over night, showing on necropsy no manifestations of definite localization.

The patient had all her teeth removed, but several months later was reported as showing no improvement.

CASE 2.—A physician, aged 36, on entering hospital, complained chiefly of pain in the eyes, severe headache, swollen eyelids and excessive lacrimation. The conjunctivae were found to be inflamed, with some edema. There was a rise of temperature with frequent chills. A blood stream infection of *S. viridans* was discovered. No foci of infection were found other than in the teeth. A live molar was extracted and found to possess a degenerating pulp. Culture gave a heavy growth of *S. salivarius*.

Animal Inoculation.—One rabbit was injected with 3 c.c. of *S. salivarius* from the tooth. In thirty-six hours, a partial paralysis of the left fore leg was noticed, and this increased in severity. In forty-eight hours, both fore legs were paralyzed, the animal was breathing very rapidly and, when disturbed, waved its head around excitedly and fell on its back. It was chloroformed while in this stage. Necropsy revealed a general involvement of all organs, with especially severe congestion of the meninges. The spinal fluid was increased in amount and very cloudy. The knee and elbow joints were swollen and contained a large amount of cloudy, purulent fluid. Cultures from the spinal fluid, medulla, meninges, cerebellum, blood and joints gave growths of the organism injected.

We were not able to obtain a culture of the streptococcus first secured from the blood of this patient, so it was not possible for us to compare the tooth strain with that from the blood. However, blood was obtained by us from the patient during convalescence and after the temperature had dropped to normal. Although there were no organisms present at that time, the serum agglutinated the homologous strain of *S. salivarius* from the tooth in a dilution of 1:200. Our type stock strains of *S. salivarius* and *S. mitis* were not affected, while our type *S. fecalis* was partially agglutinated up to a dilution of 1:50. Differing from the majority of streptococci isolated from teeth, it is clear that the present organism showed, in the rabbit, marked neurotropic tendencies, such as Rosenow has indicated for certain *S. viridans* strains. It is hoped to study further this interesting culture.

CASE 3.—A salesman, aged 39, whose condition was diagnosed as chronic nephritis, with high blood pressure and secondary anemia, had the upper left bicuspid extracted after he had been in the hospital for three weeks. One root showed no growth of organisms in sixteen days. The other gave in eighteen hours a heavy growth of a mixture of *S. salivarius* and *S. mitis*.

Animal Inoculation.—One rabbit was injected with 3 c.c. of the primary broth culture. Red blood cell counts were made at intervals for seventeen days, with no noticeable decrease. Two weeks after the injection, the rabbit began crouching in an abnormal position, with its back humped. A week later, it showed a lameness in its right fore leg. It lost weight continuously, losing 26 per cent in thirty-two days. It was chloroformed and necropsy performed thirty-three days after injection. All the organs appeared normal except the right kidney, which had on its external surface a large blister-like lesion, which has not yet been studied histologically. The wrist joint of the right leg showed an increased amount of clear fluid. Other joints were normal. Cultures from the kidney and joint fluid were negative.

One month after the extraction of the bicuspid, the patient died. Postmortem examination verified the diagnosis of chronic nephritis.

CASE 4.—A man suffering from arthritis gave an incomplete history of the malady. The tonsils were removed some time before the patient appeared for dental treatment, and relief was obtained for a short period. Then the condition became acute again. One tooth was removed and cultured, giving a pure growth of *S. fecalis*.

Animal Inoculation.—An injection of 3.5 c.c. of the broth culture was given a rabbit. For two weeks, the animal lost weight, but no other symptoms of infection appeared. Soon after this, a marked lameness of both hind legs was apparent. At the end of six weeks, the animal had lost 20 per cent of its original weight and was severely lame in its hind legs. It was then chloroformed. On postmortem, the synovial membranes of the knee joints were found to be hemorrhagic and swollen and the sockets to contain a large amount of yellow, purulent fluid. The

muscles of these legs were much inflamed. The only other pathologic condition observed in the animal was an abscess of the left axillary gland. Cultures from this, as well as from the joint fluids, were negative.

Three more teeth were extracted. One of these was negative, one gave a culture of *S. mitis*, and one showed *S. fecalis*, which was inoculated into a rabbit. No evidence of lameness was noticed until five weeks after injection, at which time the right hind leg was markedly affected. On necropsy, the right knee joint showed the same swollen, purulent condition that was seen in the first rabbit. Smears from the fluid showed a large increase in exudative cells, and a culture gave a pure growth of *S. fecalis*. The femur and tibia at the articular surfaces showed enlargement of the foramen, with a very noticeable rarefaction of the bone.

CASE 5.—A physician suffering from arthritis, had one pulpless tooth extracted and cultured. The mesial root showed a mixture of streptococcus, staphylococcus and diphtheroid. The distal root showed a pure culture of *S. mitis*.

Animal Inoculation.—A rabbit was inoculated with 3.0 c.c. of the *S. mitis* culture. In twenty-four hours lameness was noticed in the left fore leg. In three days, both fore legs were lame, while the next day the hind legs were also affected and the animal could not be made to move from its crouched position. After seven days, it was chloroformed and postmortem examination made. There was found an extreme congestion of the lungs, but all other organs appeared normal. The knee joints and left elbow joint were much swollen; the synovial membranes and surrounding muscles were spongy, with a large amount of thick, yellow, purulent fluid surrounding the joint. Cultures from the joint fluids gave pure growths of *S. mitis*. The lower ends of the femurs along the central portion of the epiphyseal line, and the upper ends of the tibias, showed a marked absorption and rarefaction of the bone substance.

CASE 6.—A nurse, with acute, exudative arthritis of the hands and one foot, suffered the first attack very suddenly, after the extraction of a tooth. The joints of both hands became severely swollen, with a lesser involvement of one foot, so that she was in severe pain and disabled for work. Two blood cultures were negative. When the patient had been in this condition for about one month, another pulpless tooth was extracted and cultured. One well filled root canal gave no growth, while the other root, the canal of which contained no filling whatever, gave a heavy growth of a hemolytic streptococcus. This is the culture referred to earlier in this paper as the one that showed the fermentative characteristics of *S. fecalis* but was strongly hemolytic.

Animal Inoculation.—Two rabbits were injected with 3 c.c. and 1.5 c.c., respectively, of the primary culture in broth. The one receiving the larger dose was found dead the next morning and, on necropsy, showed extreme congestion of the lungs, a hemorrhagic condition of all muscles and congestion of the synovial membranes. The joint sockets appeared normal, with no increase in the joint fluid. The rabbit receiving the smaller dose suffered no ill effects and continued well for one month.

The day after the removal of the tooth showing the hemolytic streptococcus, the patient felt much better, and the condition of her fingers was much improved. Five days later, a tonsillectomy was performed, after which the joint swelling rapidly disappeared and recovery took place. After the tonsillectomy, a sample of her blood agglutinated the streptococcus from the tooth in a dilution of 1:50. Of four stock strains of *S. viridans*, only one was agglutinated, namely, *S. fecalis*, showing only partial agglutination at the same dilution of the serum. In this case, it seems probable that the surgical interference was the immediate cause of an explosive infection involving the arthritic symptoms, and that the tonsillar infection was secondary.

CASE 7.—A student, aged 21, who suffered from muscular and articular rheumatism in the right hip and leg, had his tonsils removed three weeks before he came in for dental work, but with no evidence of improvement. The pulp chamber of a pulpless tooth *in situ*, the canal of which had never been entered, was exposed under aseptic technic, and the exudate taken on a cotton point and cultured. A pure growth of *S. fecalis* was obtained.

Animal Inoculation.—A rabbit was injected with 3 c.c. of the primary culture. The animal showed a progressive loss of weight, and, three weeks after the injection, became lame in one hind leg. On necropsy, the right knee was found to be much swollen, with a spongy condition of the synovial membrane

and surrounding muscles and a large amount of yellow, purulent fluid. This showed in smear a distinct increase of exudative cells, but the culture from the fluid was negative. At the lower end of the femur, at the sides of the condyles and along the epiphyseal line, and at the upper end of the tibia surrounding the articular surfaces, there was an irregular deposition of lime salts. The condition of this joint was very different from that of the joints described in the previous cases, in which there were observed absorption and rarefaction of the head of the femur and tibia.

The tooth from which this culture was obtained was treated for several weeks, then filled. The patient stated, soon afterwards, that the pains in his hip and leg had almost completely disappeared.

CASE 8.—A student, aged 30, for four weeks had been suffering with an acute attack of muscular and articular rheumatism in the neck, intercostal muscles and shoulder. Her physician, who had found no cause for the condition, finally prescribed sedatives and advised her to consult a dentist. She was found to have six pulpless teeth and an upper incisor with a large gold filling that responded weakly to the vitality test but showed no positive radiographic picture.

No teeth were extracted, but the canal of the upper incisor *in situ* was entered, with strictly aseptic technic. The pulp was found to be degenerated but still sensitive in its upper third. Material was removed on a sterile broach and cultured. A pure growth of a green producing streptococcus resulted, which fermented only lactose of the five sugars previously mentioned. This organism was possibly a variant of *S. mitis*, which ferments lactose and salicin.

Animal Inoculation.—A rabbit was inoculated with 3 c.c. of the primary culture. For five days, the animal appeared normal. On the sixth day, a lameness of the left fore leg was apparent, the animal placing no weight upon it. A few days later, the elbow and wrist joints of this leg were swollen. The animal was under observation for seven weeks, during which time no other symptoms developed, although the lameness continued in the one leg. On necropsy at the end of seven weeks, the only pathologic condition observed was an increase of cloudy joint fluid in the left elbow, accompanied by some inflammation in the muscles of the fore arm. A smear of this fluid showed an increase of eosinophils, lymphocytes and endothelial cells. Culture from the fluid was negative.

After culturing the contents of the canal of this incisor, a strong antiseptic was sealed in. Twenty-four hours later, the patient stated that her rheumatism had completely disappeared, giving her relief for the first time in three months. Treatment of the tooth was continued for several days, and the canal was filled permanently. Four months later, the patient had had no recurrence of the trouble, although she retained seven pulpless teeth.

CASE 9.—A banker, aged 50, had had an acute heart attack, which came on at the time of treatment of a tooth. There was no history of cardiac disturbance before this, but the patient had had three very severe attacks of lumbago. The heart was found to be slightly enlarged. One tooth was extracted and cultured. The canal was found to be filled through the center, leaving the flattened sides open. A culture gave a pure growth of *S. salivarius*.

Animal Inoculation.—One rabbit was injected with 3 c.c. of the broth culture. One-eighth of the body weight was lost in two days, but, after this, the weight remained constant and the animal appeared well. Twenty days after injection the rabbit died suddenly, with no previous symptoms of illness. Postmortem examination several hours after death revealed congested lungs, acute passive congestion of the liver, an excess of clear, bloody peritoneal and pleural fluids, and a voluminous, yellowish cheeselike growth completely obliterating the right ventricle. The left ventricle and auricles were normal. Direct smears and cultures from this growth showed streptococci in large numbers. Smears and cultures from the liver, lungs and blood showed no organisms. Tissue sections of the growth revealed large masses of mononuclear leukocytes, throughout which small colonies of diplococci could be detected.

A broth culture of the streptococcus from this growth was injected into a second rabbit. The animal appeared well until the tenth day, at which time a stiffness of the left hind leg was noticed. This increased in severity until the leg could not be used. The rabbit was chloroformed five weeks after injection. The left knee joint was found to be much swollen; the muscles around it were spongy, and the socket was found to contain an increased

amount of gray, cloudy fluid. All other joints appeared normal. The biceps muscle of the right leg contained several small hemorrhagic areas on the outer aspect. The lungs were found to be severely congested and edematous, but all other organs were normal, including the heart, which showed no evidence of lesions or vegetation. Direct smears of the joint fluid revealed a marked increase in exudative cells, especially eosinophils. Cultures from the blood, joint fluid and lungs were negative. This patient was reported as being much improved after the extraction of this tooth.

CASE 10.—A man, aged 30, with symptoms of gastroduodenal ulcer, suffered marked pain and tenderness in the epigastric region. The roentgen rays showed an outline of shadows about the cap and first and second portions of the duodenum. The patient had three pulpless teeth, all of which were extracted at intervals of a week.

An upper left bicuspid was first removed, contamination from the gums being avoided as much as possible. A culture from the outside of the apex before sterilization of the surface gave a heavy growth with gas production of two organisms, a gram-positive streptococcus and a gram-negative coccobacillus. A culture from the cotton filling found within the pulp chamber, after the outside of the tooth had been sterilized according to our routine method, gave a pure growth, with violent gas production of the gram-negative coccobacillus. This organism was later identified by cultural methods as *B. mucosum-capsulatum* (*Bacterium pneumoniae*).

Animal Inoculation.—Two young rabbits were inoculated intravenously with 3 c.c. of the primary broth cultures, one receiving the mixed streptococcus and *B. mucosum-capsulatum* from the outside of the apex of the tooth, and the other the pure culture of *B. mucosum-capsulatum* from the pulp chamber. Both animals died during the night. Necropsy the next morning revealed in each rabbit heavily congested lungs, and marked inflammation and congestion of the mesentery, the pyloric region and the duodenum. Tissue sections of the pylorus revealed a complete disintegration of the epithelial lining with only fibrous tissue remaining and with marked infiltration of leukocytes. Sections of the duodenum also revealed marked necrosis of the mucosa.

A third rabbit was injected with 1 c.c. of an 18-hour broth culture of *B. mucosum-capsulatum*. In five hours, the animal appeared sick, with rapid breathing and inflammation of the eye-balls. It continued sick for forty-eight hours, and was then chloroformed. The cardiac orifice of the stomach showed a diffuse congestion, with no definite lesions or ulcerations. The pylorus appeared normal, the duodenum slightly congested. Lungs and other organs appeared normal. Tissue section of the pylorus revealed a slight disintegration of the epithelium in restricted areas.

A fourth rabbit was inoculated with 2.5 c.c. of a 48-hour culture of *B. mucosum-capsulatum*. The animal was very sick for four days, losing in that time 14 per cent of its original weight. It was chloroformed on the fourth day and necropsy performed. The lungs were found to be a liver red; the pleural cavity was filled with bloody pleural fluid; the stomach was congested at the pyloric end, the duodenum was much inflamed, but with no definite ulcerations. All other organs and joints appeared normal. Cultures from the pleural exudate, lungs, stomach at pylorus, and duodenum gave growths of the organism injected. The heart blood was negative. Tissue sections of the duodenum showed a partial necrosis of the epithelial covering of the villi.

A fifth rabbit was injected with 5 c.c. of a sterile filtrate of a four-day broth culture of *B. mucosum-capsulatum*. The animal showed no symptoms of illness and gained weight steadily.

In order to confirm the classification of this organism as *B. mucosum-capsulatum* (Friedlander's pneumobacillus), the effect of intrapleural injections of white rats was noted. After passage through two animals, the organism acquired such a virulence that 1 c.c. of broth culture injected intrapleurally killed a rat in twenty-four hours, the lungs and pleural fluid showing the typical congested, edematous condition characteristic of *B. mucosum-capsulatum* infection in rats.

One week and three weeks after the removal of the first pulpless tooth, a pulpless molar and a pulpless lateral incisor, were extracted. Both of these gave cultures of *S. salivarius* from the outside of the apex, but it was doubtful whether this organism actually existed in the tissue surrounding the apex of the tooth or whether it was picked up from the mouth during the process of extraction. The canals of these teeth were

well filled with guttapercha, and, after using our usual precautions to sterilize the tooth before entering the canals, the cultures from within were found negative.

There was no improvement in the condition of the patient for three months after the extraction of the three teeth, so a gastro-enterostomy was performed. No adhesions or ulcers were found on the stomach wall or duodenum at this time. One month later, the patient was discharged as cured.

CASE 11.—A man, a teacher, aged 35, complained of debility, pains in the left chest, and occasional nausea and faintness. The heart and lungs were found in good condition. Two months before this, the patient had had a severe left sinus infection.

An upper left bicuspid was removed and cultured. A pure culture of a gas-producing, gram-negative coccobacillus, later identified as *B. mucosum-capsulatum*, was obtained.

Animal Inoculation.—Two rabbits were injected intravenously, one with 4 c.c. and one with 2 c.c. of the primary broth culture. Both animals died during the night. Necropsis of both revealed marked congestion of the lungs, with increased pleural fluid, small localized ulcerations near the cardiac orifice of the stomach, and severe inflammation of the duodenum, with minute, pin-point hemorrhages. Other organs and joints were normal. Cultures from the stomach ulcers gave growths of *B. mucosum-capsulatum*.

Tissue sections of the cardiac region showed a necrosis of the mucosa in a localized area, together with dense infiltration of lymphocytes in the surrounding tissue. The duodenum showed a more complete, general necrosis of the villi and glands, leaving a dense fibrous tissue base.

Two weeks later, a lower left molar was extracted. The pulp chamber yielded a pure culture of *S. fecalis*.

Animal Inoculation.—Two rabbits were injected intravenously, one with the primary broth culture of *S. fecalis*, the other with 1 c.c. of a secondary culture. The first rabbit died during the night, postmortem examination revealing many pin-point hemorrhages, surrounded by white, raised ulcerations, in the region of the greater curvature of the stomach. No lesions were found in other organs or joints. Cultures from the blood gave a growth of *S. fecalis*, but no streptococci were recovered from the stomach ulcers. The rabbit receiving the smaller dose appeared normal for three days, at the end of which time, necropsy was performed. The lungs were heavily congested, but other organs, including the stomach, were normal.

Until the laboratory report was given to the patient, no examination of the stomach had been made, since a gastroduodenal disturbance had not been suspected. Radiograms were accordingly taken, but at the time of writing no definite diagnosis of gastric ulcer has been made. The patient has been ordered on a diet by the physician in charge, but no improvement has yet been noted. This case will be discussed later.

GENERAL COMMENT

The first matter to which we wish to call special attention is the relation of fillings, and particularly the quality of the fillings, to pulp infections, as brought out in Table 1. Here it is shown that, of a total of seventy-four pulpless teeth examined bacteriologically, forty-three, or 58 per cent, showed infection in the root canal. Of the total of seventy-four teeth, twenty-five had no fillings; and of these, nineteen, or 76 per cent, were infected. Eighteen of the seventy-four teeth were poorly filled; that is to say, portions of the canals were left open, as in elliptical canals, or the fillings were incomplete. Of these, nine, or 50 per cent, were infected. Of the seventy-four teeth, twelve had canals that were well filled, and, of these, only five, or 41 per cent, were infected. Of the nineteen teeth in which the condition with respect to filling was not made a matter of record, but which presumably contained examples of each type mentioned above, ten, or 53 per cent, were infected. These data may be summarized as follows: no filling: per cent infected, 76; poorly filled: per cent infected, 50; well filled: per cent infected, 41.

These observations, we believe, offer a striking example of the effect of filling on root canal infection; and, to an

extent, the effect of good filling, as compared with poor. In explanation of the larger amount of canal infection in the "poorly filled" group, it may be true that those practitioners who did the poorer work in filling were also more careless regarding aseptic precautions in general, and that the difference is due to this circumstance rather than to subsequent leakage. From the practical standpoint, as favoring canal infection, one would doubtless be as bad as the other.

In reviewing the results of this study of organisms from the root canal, attention has already been drawn to the fact that we observed *S. fecalis* as the most common type, as opposed to *S. salivarius*, found by the majority of investigators who have cultured the periapical tissues rather than the root canal contents. Our results are supported only by those of Kritchevsky and of Price. It would thus appear that the form of streptococcus most commonly observed in root canals of pulpless teeth is not the same as that observed in periapical infections. Here, the most common type is *S. salivarius*, while in the pulp chamber it is *S. fecalis*.

These findings, superficially considered, might be taken to imply that the infections of the canal of pulpless teeth have a hematogenous origin from the intestinal tract, while the periapical infections have an exogenous origin, from the mouth and saliva. Broderick concludes that, since the preponderance of periapical infection is apparently due to *S. salivarius*, these cases must represent infections from the mouth. In a somewhat similar manner, we might maintain that since we (as also Kritchevsky and Price) find most root canal infections harboring *S. fecalis*, these cases must represent hematogenous infections from the intestines. Neither circumstance seems very likely, and for three reasons: 1. It would appear likely that most pulp infections start with carious lesions of the crown and would naturally involve the common mouth type, *S. salivarius*, rather than the intestinal type, *S. fecalis*, or the "enterococcus." 2. We have seen that *S. fecalis* is notorious for its absence in vital teeth with degenerating pulps; here, we usually have *S. salivarius* and *S. mitis*. 3. It would seem unlikely that infection of the pulp chamber in pulpless teeth and the infection of the periapical tissues should represent distinct pathologic entities. It is much more probable that they are mutually continuous in point of time and space, and that one contributes to the other. How is it, therefore, that we observe *S. fecalis* predominant in one case and *S. salivarius* and *S. mitis* predominant in the other?

In reviewing the work of recent years, it seems to us that too much has been made of the attempt to recognize and set up distinct and clear cut types within the viridans group of streptococci of the mouth and teeth. It may be safely said that no method of classifying has been introduced that enables us to group them in an order of relationship possessing biologic or practical significance. Each year, it becomes increasingly clearer that the viridans group, rather than being made up of distinct species, possessing immutable and constant qualities, presents to us an intergrading series of variants, which it is quite impossible to classify properly on the basis of a few reactions, no matter how well chosen.

Whether an organism is a "good species" depends entirely on the limits of its possible variations (or mutations). It is safe to say that we are profoundly

ignorant of the possibilities for variation or mutation in the case of any one of those three or four species of streptococcus with which the dental bacteriologist chiefly busies himself, on which the systematists ponder, and for which they are indefatigable in producing new schemes of classification.

Regarding the matter in this light, we are not inclined to regard our findings that *S. fecalis* is the predominant organism in pulpless teeth as possessing unusual significance other than to suggest that the primary and perhaps common microbe of dental infection (whether of pulp chamber or of periapical tissue) may assume variable forms, depending on its environment in the tissues. This is, we believe, the most logical conclusion from our findings and those of other workers. The argument, it is true, is indirect, so that our conclusion in reality becomes the hypothesis upon which further study must be based.

In discussing the results of this work, a word must be added regarding the outcome of the experiments on elective localization in rabbits. A review of the data suggests a fair percentage of localization in these tests. It may also appear that these results were somewhat at variance with earlier results reported by one of us[6] from this laboratory, in which the impression may have been given that elective localization in streptococcus infections in rabbits is of rarer occurrence than is maintained by certain other workers. The larger percentage of localizations in the present series is due to certain changes in procedure and technic and, further, to less regard for absolute specificity. These modifications in procedure relate to (1) the dose of culture; (2) the incubation period before necropsy; (3) the choice of age and weight of rabbits used for the tests, and (4) the clinical condition of the patient at the time the culture was taken.

Regarding the first point, it now seems clear that there is as much danger, as far as obscuring the manifestations of localization are concerned, in giving too large a dose as in giving too small a dose. An overdose masks the localizing effect by producing evidences of a widespread and general type of infection. We have not found entirely satisfactory the maximum size of dose recommended by Rosenow, but we do obtain results with an average dose of 3 c.c. of a rabbit of from 1,500 to 2,000 gm. with injection made intravenously.

We also recognize more clearly than was the case in earlier studies the advantages of using young rabbits for tests of this sort. A survey of our later results invariably indicates the most definite localizing infections in rabbits not over 4 months old and weighing between 1.5 and 2 kg. Such rabbits have been employed almost exclusively in all our later tests. Older rabbits may be overwhelmed with a massive infecting dose, but are likely to demonstrate no, or slight, indications of localizing effect.

Another point in which we have made a radical change in our procedure, and one which differs considerably with the earlier practice, as well as from the recommendations of Rosenow, relates to the incubation time elapsing before necropsy is performed. While, in earlier experiments, the animals were killed, on the average, within a few days after the date of inoculation, in

6. Rickert, U. G.: J.N.D.A., Research Report for the Michigan State Dental Society, 9: 690 (June) 1922.

our later work we have waited, in some cases, several weeks. And we have found, in many instances, that this delay permits the development of vigorous and definite localization lesions that could not have been detected within the first twenty-four or forty-eight hours. Aside from the evidence lying in our empiric results, and favoring the longer period, it seems to us entirely logical that the behavior of the organisms in infections representing a more or less chronic type in the human case should require time to produce similar manifestations in the inoculated rabbit. Our earlier reports were based on absolute specificity. The foregoing results have permitted other involvement of organs of the laboratory animal, without corresponding apparent involvement in the patient.

Regarding the relative degree of localizing power of the various so-called "species" of streptococcus from root canals, it is clear that all three of the chief types, *S. salivarius*, *S. mitis* and *S. fecalis*, gave localizations. *S. fecalis* gave the greatest number of joint localizations, the majority of which were purulent and accompanied by marked lameness in the inoculated animal. The only localization producing iritic manifestations was caused by a hemolytic staphylococcus taken from a patient showing eye infection. *S. salivarius* gave three types of localization—arthritic, nephritic and cardiac (heart valve). From these and other data, one can conclude that there is slight difference among these organisms as far as the elective localizing power is concerned.

When the localizations obtained are classified with respect to the nature of the infective process in the patient, as far as it was definitely diagnosed, here again it is clear that localizations in rabbits were obtained from all classes of infections—arthritic, nephritic, cardiac, gastric and iritic. In so small a number of cases, no one type of localization can be said to occur in greater frequency than another. A larger number of cases must be studied before definite conclusions can be drawn on this point.

Another point of importance in this relation is the matter of control cases. Much of the experimental work in elective localization, our own as well as that of others, suffers from the lack of adequate controls in the form of rabbit inoculations with cultures not taken from the teeth of patients, but obtained from the saliva, throat or intestines of normal individuals. We need to know to what extent, if at all, streptococci from normal tissues will effect localizations similar to those described, and until such results are available, the data from patients experiencing specific localized infections cannot yield conclusions of unassailable value or significance. We hope to undertake such adequate control features in our future work.

A phenomenon of unusual interest lies in the instance of localizing power of *B. mucosum-capsulatum*. This organism was observed in two instances of root canal infection, and we are not aware that it has been previously reported from this source. As far as the etiology of Case 11 is concerned, our interpretation of the sequence of infective conditions is this: A severe antrum infection caused by the pneumobacillus transcended the antrum area and involved the roots of the upper left bicuspid. The culmination of the root infection followed the clearing up of the antrum infection and permitted us

to obtain the bacillus from the tooth concerned. The unexpected sequel to these observations was the distinct localization of the pneumobacillus in the gastric mucosa of two rabbits following intravenous injections. These findings possess special significance in view of the incomplete diagnosis of gastric or duodenal lesions in the patient subsequent to these observations. We therefore feel justified in placing on record, first, that the Friedländer bacillus is an agent of root canal infection following antrum infection; and, secondly, that this organism has the ability to produce localized lesions in the gastric mucosa of injected rabbits. The phenomenon of elective localization in cultures from teeth thus apparently cannot be restricted to members of the streptococcus and staphylococcus groups.

In connection with this case, it is also of interest that a second tooth from the same patient gave a culture of *S. fecalis*, which, when injected into rabbits, also gave ulcer-like lesions in the stomach and duodenum. No attempt is made at this time to explain this curious fact of similar localizing power on the part of two widely differing organisms taken from the same original case but from different teeth.

To the foregoing it may be added that we have been successful in producing the dissociation of the Friedländer culture mentioned above into the S and R types, manifesting quite different growth features. We also have a bacteriophage, obtained by Dr. Philip Hadley of the University of Michigan Medical School, capable of destroying this culture rapidly. Up to the present time, no attempt has been made to employ this in the treatment of the case, the actual diagnosis of which is still somewhat a matter of doubt. This instance suggests, however, the possibility of using the bacteriophage in the treatment of recognized infections caused by *B. mucosum-capsulatum*, *B. ozenae*, *B. rhinoscleromatis*, or other members of the capsulated group.

CONCLUSION

We may be permitted, perhaps, to express once more our convictions regarding the points most demanding attention in the investigation of the problem of pulp and periapical infections in themselves, and in relation to other localized infective processes in the body. As suggested, we believe that, as far as increasing knowledge of the etiologic factors is concerned, the collecting and classifying of numerous cultures from lesions in infective teeth possesses in itself little significance or advantage. Evidence is increasing that, in the case of many bacteria, stability of type characteristics, under changing conditions of environment, is a rare phenomenon, and that the rule is instability, variation and, more than likely, mutation. The pleomorphic attributes of the streptococci as a class are being forced on us from many sides, and the immense amount of labor that has gone to the task of formulating classifications that might be of some permanent value, we must admit, has not been justified in experience. We still have no trustworthy scheme whereby it is possible to classify the members of this group; nor is it likely that we shall have. If this is true, as many are coming to believe, there must be a reason. And the reason is, probably, that the so-called "good species" of streptococci are not stable or fixed, but ever-changing. There is not a single characteristic of a streptococcus type that is not the subject of variational,

and perhaps of mutational changes; and this is true not only for those organisms common in dental infections, but also in other streptococcus infections as well. It all means that we have not properly appreciated the significance of environment in modifying the type or state of the micro-organisms. We have attempted to classify the apparently stable types, when we momentarily observe them, as we might attempt to classify the successive configurations observed momentarily in the kaleidoscope. The only difference is, perhaps, that the changes in the microbe occur a little more slowly; but, an adequate jolt in the environment modifies the picture in respect to both.

We believe, moreover, that this conception of the instability of the streptococcus type has an important bearing on the interpretation of findings in localized infections and secondary foci in relation to the primary focus, such as a tooth or a tonsil. The mere finding of *S. fecalis* in a root canal is perhaps no evidence that the infection was originally produced by a fecalis strain. And, if we should find *S. mitis* or another organism in a remote focus of infection in the same individual, we could not necessarily assume that this organism had no relation to the original fecalis-infected pulp canal. We believe it probable that subsequent study will demonstrate that the form of streptococcus that we encounter in a certain lesion is not a mark of stable and unvarying qualities, but is something impressed on that organism by the force of its environment. No doubt some characteristics of the cell are more stable, others less. But our contention is that the full picture of the organism, at any moment in its life history, is the product of environmental pressure coupled with the inate capabilities of the cell for adaptation and mutation.[7]

Finally, we may express our belief that we may do well to accept this view as a working hypothesis in connection with studies on the eitology of tooth infections. If it can be disproved, we are no worse off than before in our knowledge of the etiology of peridontal infections. If it can be proved true, we shall find ourselves in a more favorable position to attack, from a new point of view, many of the difficult phases of the problem of elective localization correlated with dental infections.

SUMMARY

This paper presents the results of a study of the etiology of root canal infections, investigated by means of culturing from the pulp chamber; also, a study of the localized infections in rabbits caused by the injection of the cultures obtained from teeth. The chief results were as follows:

1. In the study of seventy-four pulpless teeth, we obtained positive infections in forty-three, or 58 per cent.

2. In the teeth with no fillings, the percentage of infection was 76; in teeth poorly filled, 50; in teeth well filled, 41.

3. The predominant organism found in the canal of pulpless teeth was *S. fecalis*. It was not observed in teeth with vital or degenerating pulps.

4. Second in frequency was *S. salivarius*, and third, *S. mitis*. Other or-

7. In this connection, it is of interest to note that Price (Fundamentals Suggested by Recent Researches for Diagnosis, Prognosis and Treatment of Dental Infections, J.A.D.A., 12: 641 [June] 1925) has already made a distinct start on this problem in his study of the effect of iodoform in the mutation of the streptococcus.

ganisms from pulp canals are also reported.

5. In two instances, we isolated from root canals an organism agreeing in all essential respects with *B. mucosum-capsulatum*. With this culture, we were able to produce in rabbits definitely localized gastric lesions.

6. In several instances, among eleven recorded, we obtained distinct localization lesions in rabbits injected with cultures from root canals.

These findings are here discussed with respect to their departure from, or agreement with, the results of other investigators.

The conclusion is reached that further attempts to classify the streptococci from teeth according to present-day methods can help little in throwing light on the specific etiology of canal and periapical infections.

We venture to propose the hypothesis that the streptococci chiefly responsible for root canal and periapical infections of the teeth all belong to the same type; that this type is highly unstable and appears as *S. fecalis, mitis or salivarius*, or another form, depending on the pressure of the environmental conditions, coupled with intrinsic mutational capabilities.

It is further suggested that new light may be thrown on the specific etiology of pulp and periodontal infections from the tentative adoption of this hypothesis in further research on these and related problems involving the green-producing streptococcus.

THE VIRULENCE AND CLASSIFICATION OF STREPTOCOCCI ISOLATED FROM APICAL INFECTIONS. A PRELIMINARY REPORT*

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THIS preliminary report deals with the bacteria recovered in chronic apical infections in apparently healthy individuals. Apical infections are relatively high in man in comparison with other infections throughout the body, especially infections of a chronic type. A predominating number of persons carrying a low grade chronic infection around the roots of teeth are otherwise apparently in good health. Is this due to the natural or acquired immunity of man; is it due to the fact that the invasive powers of bacteria of apical infections vary so greatly, or is there no relationship between apical infections and the direct cause of infection in other parts of the body? Our present study seems to show that the virulence of the streptococci varies greatly and that those organisms recovered in the case of persons apparently healthy are not markedly pathogenic and do not, as a rule, produce lesions when injected into rabbits.

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Sixty-Seventh Annual Session of the American Dental Association, Louisville, Ky., September 23, 1925.

METHOD OF STUDY

In our present study, we have followed Rosenow in his method of collecting specimens and making cultures and in his methods employed in animal experimentation. In the majority of cases, a culture was made of the granuloma and scrapings from the root canal immediately on extraction. All work was done with sterile instruments over sterile towels and gauze. In extraction, appointed operators used the most generally accepted aseptic method. The tooth and granuloma were brought to the laboratory in sterile gauze or in a sterile test tube. The tooth was immersed in alcohol and flamed. The granuloma was removed with sterile forceps and put in a tube of sterile physiologic sodium chlorid solution containing a small amount of sand. The tube was then well shaken to macerate the tissue. Cultures were made into hormone glucose brain broth and hormone glucose brain agar which had been previously heated and cooled to 40 C. This medium was made from a beef heart infusion containing 1 per cent peptone, 0.5 per cent sodium chlorid and 0.2 per cent glucose filtered through glass wool and the hydrogen ion concentration brought to 7.8. In our later study, we did not attempt to sterilize the granuloma with alcohol and flaming, but removed it with sterile forceps and dropped it immediately into glucose brain broth. We were interested to know whether this method of sterilizing was injurious to organisms present in the granuloma. Interesting data recorded in this paper show that this last method is not at all reliable. Cultures from the root canals were made by clipping off the apex with bone cutting forceps, the tooth being held in sterile gauze. A sterile broach was passed into the root canal, and cultures were made on hormone glucose brain broth and agar, and incubated from twenty-four to forty-eight hours, as some of the organisms were apparently slow growing.

Ten cultures in all were made from the sockets of upper anterior teeth. A sterile capillary pipet was introduced into the apical region immediately on extraction. Extreme care was used to avoid contamination. The fluid was cultured similarly to the granuloma and root canal scrapings. Gram-stained smears were made to classify the streptococci as to size, length of chain, etc. Blood agar plates were made of all primary cultures to determine hemolysis. Subcultures were made from the blood agar plates into plain hormone broth. Sugar fermentation medium, lactose-mannitol and salicin, made from beef heart infusion with Audrade's indicator, was used for classifying the streptococci. In the first seventy cases, bile solubility tests were not made. Fermentation test was made only on long chain streptococci. Medium sized rabbits were used in our experiments. From 2 to 5 c.c. of a twenty-four hour broth culture undiluted was the dosage used in the virulence test. The animals were inoculated intravenously, and were observed daily for symptoms. They were permitted to live from two to eleven days. Chloroform was administered and necropsies were made. Cultures were made of the heart blood by inoculating glucose brain broth. All joint lesions were cultured in the same medium. Careful study was made of gross lesions, but no microscopic work was done. Experimental data are given in Table 1.

TABLE 1.—EXPERIMENTAL DATA.

No. of Cases	Streptococcus Viridans	Streptococcus Hemolyticus	Mixture of Streptococcus Viridans and Streptococcus Hemolyticus	Organism Other than Streptococcus Viridans and Streptococcus Hemolyticus	Sterile
68 root canals	45—66.21%	2= 2.9%	3= 4.5%	4= 8.8%	14=20.6%
34 granulomas	27=79.4%	0= 0 %	4=11.8%	2= 5.9%	1= 2.9%
10 sockets	70=70 %	2=20 %	0= 0	1=10 %	0

From cultures made of sixty-eight root canals, forty-five, or 66.2 per cent, showed a growth of *Streptococcus viridans;* two or 2.9 per cent, showed *Streptococcus hemolyticus;* three, or 4.5 per cent showed a mixture of *S. hemolyticus* and *S. viridans;* four, or 8.8 per cent, showed a growth other than streptococcus, either a staphylococcus or a bacillus, and fourteen, or 20.6 per cent, were sterile. Of the thirty-four cases of granulomas studied, twenty-seven, or 79.4 per cent, showed *S. viridans*; four, or 11.8 per cent, showed a mixture of *S. hemolyticus* and *S. viridans;* two, or 5.9 per cent, showed growth other than *S. hemolyticus* and *S. viridans,* and one, or 2.9 per cent, was sterile. No hemolytic streptococcus except in combination with *S. viridans* was cultured from granulomas. Of the ten cultures made from the sockets of teeth, seven, or 70 per cent, showed *S. viridans,* and two, or 20 per sent, showed *S. hemolyticus.* No one showed a combination of organisms, and one, or 10 per cent, was sterile. In the case of the ten socket cultures, root canal cultures were made on the same teeth in nine cases, of which seven showed *S. viridans* and two, *S hemolyticus.* Likewise, cultures were made on the associated granuloma in three cases. Two showed *S. viridans* and one was sterile. Our study shows that *S. viridans* is the predominating organism in both root canals and granuloma. *S. viridans* is found to predominate to a slightly higher degree in granulomas than in root canals. *S. hemolyticus* appeared only in combination with *S. viridans* in granulomas. A higher percentage of negative cultures was found in root canals than in the granuloma. Cultures made from material aspirated from the depths of the socket of extracted teeth yield substantially the same results as root canals and granuloma.

CLASSIFICATION

The classification of organisms was taken up several months after the study had been started. Holman's method was used. Of the twenty-five strains of bacteria forming green colonies on blood agar and isolated from root canals, seventeen were streptococci and eight were pneumococci. The classification is given in Table 2.

TABLE 2.—CLASSIFICATION OF S. VIRIDANS FROM ROOT CANALS

Strain	S. Viridans	Per Cent
8	S. nonhemolyticus II	47.0
6	S. mitis	35.5
2	S. nonhemolyticus III	11.5
1	S. fecalis	6.0

Of fourteen strains of green-producing organisms isolated from granulomas, both when the tooth had and had it not been flamed previously, twelve

were streptococci and two were pneumonocci. The classification is given in Table 3.

TABLE 3.—CLASSIFICATION OF S. VIRIDANS FROM GRANULOMAS.

Strain	S. Viridans	Per Cent
1	S. nonhemolyticus I	8.3
6	S. mitis	50.0
1	S. nonhemolyticus II	8.3
3	S. salivarius	25.0
1	S. nonhemolyticus III	8.3

Of five strains of hemolyzing organisms

Strain	Source	S. Hemolyticus
1	Granuloma	S. infrequens
1	Granuloma	S. pyogenes
1	Granuloma	S. hemolyticus II
1	Root canal	S. pyogenes
1	Socket	S. hemolyticus II

S. nonhemolyticus II strain predominates in root canal cultures, with *S. mitis* second. *S. mitis* strain predominates in the granuloma cultures.

S. salivarius did not appear in any of the cultures made from root canals, nor in the granulomas until after we had changed our technic in culturing.

VIRULENCE

In our study, sixteen medium size rabbits were inoculated intravenously with either (1) primary cultures; (2) pure cultures of *S. viridans* or *S. hemolyticus*, or (3) a mixture of these pure strains. The strains used were isolated from the first seventy teeth studied. Data are given in Table 4.

The strains were freshly isolated from eight granulomas, six root canals and one tooth socket. Of the sixteen rabbits, nine, or 56.3 per cent, gave negative findings, and seven, or 43.8 per cent, showed lesions. Of the seven rabbits that showed lesions, five, or 71.4 per cent, were injected with *S. viridans* isolated from granulomas; one, or 14.3 per cent, with *S. viridans* isolated from the root canals, and one, or 14.3 per cent, with *S. viridans* isolated from the socket of a tooth. Of the seven rabbits, five developed joint lesions; three, lesions of the stomach; and three,

TABLE 4.—RESULTS OF ANIMAL EXPERIMENTATION

Animal	Dosage C. C.	Type of Streptococcus	Source	Days Permitted to Live	Joint	Stomach	Liver	Heart Blood
I	2	S. viridans	Socket	11	—	+	—	—
II	3	S. hemolyticus	Granuloma	10	—	—	—	—
III	3	S. viridans	Granuloma	10	—	—	—	—
IV	3	Equal parts S. viridans and S. hemolyticus of Rabbit 2 2 and 3	Granuloma	9	—	—	—	—
V	5	S. vir.	Root canal	6	—	—	—	—
VI	4	S. vir.	Granuloma	2	—	—	—	—
VII	3	S. vir.	Granuloma	7	+	—	—	—
VIII	3	S. vir.	From Rabbit 7	3	+	—	—	—
IX	3.5	S. vir.	Granuloma	2	+	—	+	+
X	3	S. vir.	Root canal	6	—	—	—	—
XI	5	S. vir.	Root canal	7	—	—	—	—
XII	3	S. vir.	Granuloma	5	—	+	+	—
XIII	3	S. vir.	Root canal	6	—	—	—	—
XIV	4	S. vir.	Root canal	6	—	—	—	—
XV	5	S. vir.	Root canal	4	+	+	+	+
XVI	3	S. vir.	Granuloma	4	+	—	—	—

lesions of the liver, and in two cases, culture of the heart blood was positive. Of the latter, one culture yielded a staphylococcus and one *S. viridans*. Of the sixteen rabbits, six of which were injected intravenously with *S. viridans* isolated from the root canal, one developed a joint lesion from which a creamy tenacious pus was obtained yielding *S. viridans* in pure culture. Six rabbits were injected intravenously with *S. viridans* isolated from granulomas. Five developed lesions in the joint, or 83.3 per cent of the rabbits developed lesions as against 16.6 per cent of the rabbits which showed lesions when injected with *S. viridans* from root canals. The virulence of *S. viridans* of the granuloma strain is greater than that of these organisms from the root canal. The strains used were not classified as to sugar fermentation. In our later experiments, the type will be determined. It is interesting to note that the strain *S. hemolyticus* from a granuloma did not produce any lesions alone or in combination with *S. viridans*, which was present in the primary granuloma culture. Two examples of our virulence test will be interesting to note here. March 25, we injected Rabbit 7 with 3 c.c. of a pure strain of *S. viridans* isolated from a granuloma. On March 26, malaise was noted. No further symptoms were noted until April 1, when lameness developed in the right hind leg, which was swollen. On necropsy, a purulent tenacious pus was present in the joint cavity and likewise the muscles adjoining the patella region. Cultures yielded a pure strain of *S. viridans*. The heart blood was negative. We did not classify this organism with sugar fermentation. We injected 3 c.c. of a 48-hour growth of the streptococcus strain isolated from Rabbit 7 into Rabbit 8, April 3. April 4-6, the animal showed general malaise; April 6, lameness of the right hind leg was observed. Necropsy, April 6, showed all legs normal, with the exception of the right hind leg. No lesions were found in the muscle or internal organs. There was a purulent tenacious discharge from the metatarsal joint of the right hind leg. Cultures yielded a pure strain of *S. viridans*. The heart blood was negative. This lesion developed in two days as against the joint lesion of Rabbit 7, which developed in seven days. An increase in virulence of the strain is gained on animal passage, and localizing power is retained.

SUMMARY

1. *Streptococcus viridans* was the predominating organism isolated from the root canal and granuloma of apical infections.

2. According to the Holman classification, *S. nonhemolyticus II* predominates, with *S. mitis* second, in root canal cultures. *S. mitis* predominates in granuloma cultures.

3. *S. viridans* isolated from granulomas and root canals failed to produce lesions in the majority of cases when injected intravenously into rabbits.

4. *S. viridans* cultured from the granuloma produced a greater number of lesions when injected into rabbits than *S. viridans* isolated from the root canal.

5. The pneumococcus occurs more frequently in the root canal than in granulomas.

DISCUSSION OF PAPERS OF DRS. RICKERT AND LYONS AND MRS. HADLEY AND MISS NICHOLS

E. E. Haverstick, St. Louis, Mo.: Were the specimens from the canals of roots that had granulomas on them or that did not have granulomas on them?

Anna C. Nichols, Chicago, Ill.: I made root canal cultures in each case in which there was a granuloma. Unless the root canal was closed with bony forms, the canal was not opened. But in each case I intended to make a root canal culture of the granuloma tooth.

U. G. Rickert, Ann Arbor, Mich.: We tried to compare the growths taken from the periapical areas with those from the root canal. Our object was to see whether we could not demonstrate variations, when grown under the variable conditions. So we also cultured both.

A member: Had those root canals been treated previously, and if so, by what method?

Miss Nichols: Some of the teeth were treated, and some of them had guttapercha fillings. Occasionally, I could remove part of the guttapercha and put in the broth, and I would get streptococcus growth even in that case.

Dr. Rickert: Miss Nichols has answered for me, too. Of course, we have had many cultures in which the pulp had died and had never been treated. We cultured granulomas too, but our results are identical. Our work was in accord with the report of Miss Nichols. We took broaches and worked out the guttapercha that was in the canals, when we were culturing the pulp canal contents. It might be said, since you have asked the question, that when the apical end is well sealed and there is a good filling in the coronal part of the tooth, we seldom get growths from the guttapercha taken from the canal, that is, within 2 to 3 mm. from the apical end. Why should we? The sealing prevents diffusion in that area. We have no pabulum for them to grow on. If there were organisms, they would die from food exhaustion just as if they were in an incubator. The idea is this: that all pulpless teeth, if infected all the way through the root, must have diffusion of nutrient material. Otherwise, the organisms die.

Edouard M. Hall, Kansas City, Mo.: Dr. Haverstick's question has not been answered. I should like to know whether they ran separate groups of root canal cultures on teeth having no periapical involvement, and another separate group of teeth having periapical involvement to see whether or not there was a distinct classification, or difference in classification of the root canal group, or simply the possibility of the effect of a lack of nutrition for organisms taken from the root canal as compared to cultures for periapical virulence. That, I believe, was what Dr. Haverstick wished to know. If we take cultures out of the root canal of a tooth having a granuloma and find a difference of virulence in the root canal culture as compared with the culture taken from the granuloma on the same tooth, that is due simply to environment or nutrition, or something of that kind. But if you take entirely separate groups, the results will be different.

Miss Nichols: I have had some data, but not many. I injected one rabbit with *Streptococcus viridans* isolated from the granuloma and a lesion in the joint and also in the stomach developed. With an isolated *Streptococcus viridans* from the root canal of the same tooth having a granuloma, a joint lesion developed. At this time, I have little to say on that question.

Dr. Rickert: We did not intend just to culture apical tissue where there were evidences of marked periapical involvement. (I object to the meaningless term granuloma.) We made cultures in all cases in which histories had been taken, whether there were such changes or not. We cultured the apical area as well as the root canal contents, so, if we go through the record, there is a record as to whether there was marked involvement at the apex, and I think that will be published in the report. We were not trying to culture periapical tissue just when there was definite pathologic change. We tried to take cultures in all conditions. Does that answer the question?

Edouard M. Hall: That answers the question, and only intensifies the point that I had in mind. I believe that testing separate groups would help. Much depends on environmental influence. The granuloma evidences the presence of a definite reaction, and there is a definite environmental influence

there, but the trouble is that there are so many variables that it is a question how we are going to meet them all.

Louis G. Burgard, Louisville, Ky.: With a pulpless tooth, or all roentgen-ray evidence showing no periapical lesion, would it be possible to have infection present that would be detrimental to the host without producing a periapical lesion?

Miss Nichols: I would say, yes. In culturing root canals when there was no granuloma present, some bad lesions were produced in rabbits that were injected intravenously.

Dr. Rickert: I should say especially so with the arthritics. In these cases, we find that the majority of them have practically no evidence of periapical pathologic involvement radiographically, and yet we get the organisms from cultures. In fact, it is my opinion that some of the changes are only defense reactions, and patients that cannot react are suffering from infected teeth. That has been our experience in going over a great many of these cases, and I may also include the cardiac changes. There are quite a number of them that might be included in there. I might cover the whole field, but I will at least touch on the arthritics. I have had experience enough to know that the majority show practically nothing, and if we curet the apical areas, we may find the least bit of resorption, in an area not over 1 mm. in diameter, but there will be no definite quarantine. The roentgen rays have no value when it comes to determining whether the tooth is a menace to the patient or not. It is only an adjunct in our general diagnosis.

Leonard C. Snowden, Dallas, Texas: Do you devitalize your pulps and treat them, and what definite treatment do you give the teeth? Or, do you select the teeth you do not know were treated, and what is your course of treatment?

R. W. Bunting, Ann Arbor, Mich.: In view of the fact that we were discussing a question that is of vital importance, may I ask you to defer that question just a moment?

Charles R. Jefferis, Wilmington, Del.: I should like to ask Dr. Rickert if he has ever examined a tooth that was negative and found it sterile, or have all the pulpless teeth you have examined been infected?

Dr. Rickert: No. I have to admit that too many of them are infected. We want to give you really intelligent information. This year our work has been an attempt to do more than prove our point by cultural methods. We have taken the fresh apical tissues, or the pulp canal contents, and we have put them in a salt solution and examined them microscopically with the use of the dark-field illumination to see whether some of these areas showed organisms on direct smears that we did not obtain when grown on culture mediums. We were afraid we were missing something. Roughly, our figures are about the same as Miss Nichols, with probably not quite so high a percentage of positive results. That could easily result from variations of types of patients studied. Roughly speaking, we find that about half of all pulpless teeth cultured are infected. But do not take that as signifying that all the pulpless teeth in the mouths of this audience this morning are 50 per cent infected, because our cases were taken largely from sick people. A few years ago, we cultured teeth at random. We cultured many pulpless teeth without histories, and the percentage of infected teeth taken in this way was much lower than it is among the sick. Does that answer your question?

Theodore B. Beust, Louisville, Ky.: In connection with the question of Dr. Burgard, I should like to ask whether or not a greater number of the varieties of streptococci entered the circulation through tonsillar crypts or through the gingivae than could possibly enter the circulation through entities which you cannot differentiate microscopically, or with the help of the roentgen ray. Which of the two is of greater significance in focal infection, the tonsillar crypt or the particular tissue or root canal which cannot be pronounced as in a pathologic condition?

Miss Nichols: I have done quite a lot to work on tonsils. We have a physician that makes cultures on almost every pair of tonsils that come in, to determine whether hemolytic streptococci or *Streptococcus viridans*, or both, are present. He has great faith in the removal of the tonsils when the hemolytic streptococcus is there. From our work, I am sure that a great many tonsils are at fault, but whether there is a relationship between tonsils and teeth in focal infection, I can't say.

Dr. Rickert: I am in the same position there. I don't think any one knows the relative importance or significance of tonsils and teeth. We very often find that the physician likes to pass the case on to the dentist and have him remove the patient's teeth first. Then he takes out the tonsils. We prefer it the other way. Quite often we get a marked reaction when the tonsils are taken out, which is not always permanent. Then we take out the teeth, and often, when both are removed, we get rather pronounced results. I have been asked that question a great many times, Dr. Beust, and I can't answer it. Some physicians and dentists think teeth are much more important than the tonsils, and others think otherwise.

Dr. Burgard: Were any of those cultures made on deciduous teeth; and if not, why not?

Miss Nichols: Not to my knowledge.

Dr. Rickert: That is a good question. In this report, no deciduous teeth are included. I have cultured only deciduous teeth taken from my own practice. That might answer the question. They are not included in this report, because dentistry has not developed to the point yet where the majority of us appreciate the importance of dealing with children with the gravity that we do adults. That is why we are working more on the adult cases.

Dr. Snowden: My question hasn't been answered yet. Are you devitalizing teeth in your own cases, and by what method do you treat them, etc.? A dead tooth does not necessarily mean anything. Most of them are devitalized and treated, in my opinion, without sterilization, as we ordinarily would attempt to do, or were taught to do. The question in my mind is, is it possible to devitalize a tooth, treat it successfully and have a healthy tooth with one method any more so than with one method of filling the root canal? Do you ever check through that method, or do you take the dead teeth as they come to you?

Dr. Rickert: These cultures were all made from teeth that had been treated in almost every part of the country. Many of our patients were brought to the hospital, and I made a rule to culture those cases that I treated myself. The teeth that we cultured had, as a rule, very inadequate fillings. Many of them proved quite well filled from radiograms, so that the conscience of the operator had been appeased, when he had a root canal point thin enough that he could plunge it to the apex of the tooth, so that the radiogram showed, at least, that there was a canal point down somewhere near the apex. Many of these points could be withdrawn with a broach without any difficulty at all. In ellipsoid or oval canals, there was no attempt at complete filling. There might just as well have been nothing there; for such fillings are worthless. Yours is a practical question, and if we are to get anything from these research reports, we are entitled to certain conclusions. In our reports, we have purposely avoided such conclusions. There is great danger that the experimenter sees only the evidences that support his personal views. For the present, the dentist must draw his own conclusions. The conflict of opinions based upon research work has too often been due to the experimenter's injecting his own prejudiced conclusions, often based on preconceived ideas. For that reason, in this report, we have avoided elaborate deductions. I draw my own conclusions but refuse to force them on you. Can a tooth be treated so that it will remain sterile? That is the practical application of the work that we are doing. I have in my collection of slides one tooth from which the pulp was removed in 1870, and the patient is still in good health. We haven't had an opportunity to culture that. The owner isn't going to come to the laboratory and let us take the tooth out to see whether it is infected. You see the problem that we are up against. We have had a great many teeth that have been successfully treated. Such teeth have given service for twenty-five or thirty years, and show absolutely no evidence of injury to the patient. The strongest argument I can give in answer to your question is this: We have cultured our own root canal fillings, in which there was a slowly diffusible antiseptic incorporated. Occasionally, we have had an opportunity to do that, and we have never found any of the cases infected when the canal was really filled with filling materials incorporated with slowly diffusible antiseptics. This does not include fillings that lost volume by solution. There are such materials on the market, but of the few insoluble fillings that we have been able to take out, the cultures have shown

no indication of infection. The nearest thing that we could do in the laboratory (which is not answering your question as it should be answered) was to take different filling materials, manipulated by different workers, and have them placed in laboratory teeth. These teeth were placed in bouillon inoculated with a mixture of strains of streptococci which we have collected from various types of patients. We thought that we would subject it to the severest test possible. This bouillon was changed at intervals of a week. Every thirty days, a tooth was taken out and the outside was sterilized. We took out the root canal filling material, just as I have been doing with those teeth that were extracted, and cultures were made in this way. I am not here arguing for slowly diffusible antiseptic root fillings. I don't know whether we are coming to that, but it is worthy of a trial. It offers a hope until we find something better, and it is for this reason that I have tried this experiment. In no instance have we found the pulp canal contents infected. That is quite contradictory to the ideas that have been given to you by those who say the organisms adapt themselves to the antiseptic, which is a laboratory possibility, but a practical improbability, as we judge from our own work. Does that answer your question?

Dr. Snowden: Patients that I examined by roentgen ray fifteen years ago are in perfect health, and those dead teeth have been in there since then. Some had shown considerable infection or rarefaction at the apex twelve or fifteen years ago. These patients still carry the teeth and are in perfect health. I don't know why one patient who has a dead root removed improves, and another patient can carry a granuloma as large as a pea for twenty or twenty-five years without any physical disturbance whatsoever. I think that it is a question of immunity and susceptibility to infection.

Dr. Rickert: We have to consider the biologic makeup of the patient that Dr. Hall spoke of. That is determined by a variable number of factors. Part of it is hereditary, part of it is environmental. We have great hopes that diet will help us solve some of these problems, in a measure, at least. The work that Miss Nichols and I have been doing has been intended to help us, for instance, in the classification of organisms. We had hoped that, in a patient of a certain biologic makeup, we would find a preponderance of a certain type of organisms, telling us that this patient had a type of infection usually dangerous to that type, but we had inconclusive results. From a practical standpoint, the thing to do is to determine by careful diagnosis all possible factors before we treat any pulpless teeth. We hope that some such work as we are doing may enable us to tell sooner or later whether or not this or that tooth should be treated. That is the thing we have in mind. Our efforts are not conclusive at the present time.

M. D. Zimmerman, Pottsville, Pa.: What is the value of vaccine after-treatment following extraction in focal infection cases?

Dr. Rickert: We haven't done much with vaccines. We have been waiting for others to use them. It is our opinion that this is one therapeutic agent that is very likely to be overworked. Whether the future is going to prove to us that vaccines are of service in management of our cases, I do not know. I have more hope in dealing with the problem through suitable surgery. It is the consensus of opinion in the medical department of our institution that we should go slow. It is all right in experimental cases, but we must take care in the matter of vaccine, because we are injecting foreign material, too often with only empiric reasons for doing so. I wish I could answer your question, but I can't.

R. L. Girardot, Detroit, Mich.: I should like to make certain that both Miss Nichols and Dr. Rickert are stating that wherein they obtained positive reaction from the canals of root filled teeth, it was from teeth that were radiographically and microscopically poorly filled teeth.

Dr. Rickert: There is one table in our report that I did not read, because so much has been said dealing with that problem. We did consider the type of filling. In cases in which the apical end was open as compared with those in which the apical end was well sealed, it was observed that there were three times as many infective. I won't say three times, but at least twice. I think there were nearly three times as many of those fillings as those that were really sealed at the apex. Does that answer your question? That is given in the table in the report. We don't

know why it is that some of those that were well sealed at the apex had periapical infection. We made this study because the whole treatment of pulpless teeth is based upon this one proposition: that if you remove the structure of the tooth within the cementum (I don't mean remove the tooth, but eliminate by suitable treatment that continuous source of infection), the apical region will take care of itself. We did this work to check up in an effort to see whether that conception was on a strong foundation or not; whether, if you removed the tooth by treatment as a continuous source of infection, the periapical tissue could take care of itself.

J. O. Hall, Waco, Texas: May we hope that these different research workers will get together and give us some definite conclusions based upon the knowledge gained up to the present time, as to whether the pulpless tooth shall remain, and under what conditions it shall remain, and as to other conditions, when it shall be removed, and under what conditions it shall be removed? I am a general practitioner. I would like to take home some definite knowledge.

Edward H. Hatton, Chicago, Ill.: It may seem that the problem Miss Nichols has been working on is an exact duplicate of Dr. Rickert's problem. I asked Miss Nichols to find out for me, if she could, the significance of bacteria that are found in the periapical regions of teeth that carry granulomas. I was careful to supply her with material out of the extraction room, most of it carefully selected by myself, to avoid contamination. I asked her to tell me what she could about the organisms found around the apices of the teeth that had definite granulomas, that showed in the radiogram. Some of them came from teeth that had been treated and filled. She has told you today that not all of them produced lesions in experimental animals; a considerable number did not. She has told you that more produced lesions from the granulomas than from the pulp canals. To me, that is extremely significant. The reason we can't give you certain information is because Dr. Rickert, Dr. Price, Dr. Bunting and I can't agree. Dr. Price will tell you one thing. He will say that all pulpless teeth should be removed as well as some that Dr. Rickert mentioned. I think that is fair enough, isn't it, Dr. Price?

Weston A. Price, Cleveland, Ohio: If you wish to have me discuss the paper, I shall be glad to answer your question.

Dr. Hatton: Right now, is that a correct statement, that you believe all pulpless teeth should be extracted, and you would include some others that Dr. Rickert mentioned in which there had been extensive restorations, and efforts had been made to protect the pulp, and the pulp subsequently became infected? He spoke of such teeth as being a particular menace.

Dr. Price: Since I did not have the privilege of hearing the papers and the discussions, owing to being on the program in another section I must answer the question in a general way. I believe that many teeth with vital pulps are more dangerous to the individuals carrying them than are root filled teeth carried by the same individuals. Further, I believe that many of the teeth that are root filled may, and will, become infected, even though they may not yet be infected. The time when they will become infected will largely depend on the overload of the patient. Therefore, I must qualify the question as to the extraction of that tooth by saying that a great deal depends on the danger of the overloads, the age of the patient and various contributing factors. For example, a mother or expectant mother cannot, with safety, be given the treatment that may be given a young woman not a mother or an expectant mother. Further, a person at 55 years of age cannot be given the same treatment that would be given to a person 25 years of age. But all pulpless teeth, root filled or not, harbor so much danger of becoming infected that they should be extracted, though the time as to when they are to be extracted will depend on several contributing factors. If the patient belongs to a family in which there is a low defense for streptococcal infection, it had better be soon. That is ascertained by a questionnaire. If the patient is in another group with a very high defense and not much in danger of overloads, and if it is a tooth that is greatly needed by that patient, I would advise you to do what I do: retain some of those root filled teeth, because I believe they are of more value to the patient in the mouth than out. But I want to say there are not a great many of those cases as compared to the number of pulpless teeth. As to how we shall determine the defense of

the individual in regard to streptococcal infections: it is my belief that we have, or will have very shortly, available complement fixation tests for different types of streptococci. We can thereby tell to which type the patient is sensitized. I think it will be possible to get further information in the case of an adult. I probably should not go into extensive detail, without an elaborate discussion; but that is a hopeful thing for us to anticipate. With regard to the general problem as to what destroys the organism and how long they will live, I did not hear Miss Nichols' paper, but from the question that has been asked me, and from the discussion that has been made by Dr. Hatton, I am led to make this statement, that ordinary blood, that is, the blood of an average individual, will devitalize and digest most of 1,000 living organisms, or 75 per cent of 1,000 living organisms, in 10 drops of defibrinated blood in ten minutes. I should like to ask Dr. Hatton how he expects to find organisms, and under what condition he expects to find those organisms when he cultures at the apex of the root, unless the patient is one who is not able to carry his defensive mechanism, which I have just explained, right up to the surface of the tooth?

Dr. Hatton: Dr. Rickert and I believe that a more considerable number of pulpless teeth may be preserved in the mouth than, I think Dr. Price does. While the problem of pulpless teeth is a problem of immunity of the individual and of the invasiveness of the organ, after all, the final solution of the question as to whether or not pulpless teeth are to be in good or bad standing is not our problem—Dr. Price's, Dr. Rickert's or mine—but it is your problem, because you are either going to make or ruin the pulpless tooth by either your ability to develop a suitable technic for filling and treating root canals, or your inability to do so. I was asked how we determine whether or not organisms that are found in apical granulomas are recovered from the mouths of people who are in good health or from those in poor health. If they were in perfect health, there wouldn't be any organisms there, and if there are organisms there, they are in poor health. That is presumably the question. I can't conceive of the situation at the apex of a tooth as different from any other part of the body. I do not consider a person in poor health because he has an appendix vermiformis that is chockful of organisms, walled off from the abdominal cavity, possibly having an outlet, possibly not having an outlet into the bowel, or organisms in the crypt of the tonsil, possibly having an outlet in the mouth and possibly not having an outlet. I do not consider those organisms any different from organisms found around the root of a tooth. The tooth is different from every other part of the body, in that the body is everywhere else defended by a covering of epithelium or epithelium-produced structures. When once the epithelium-produced enamel is destroyed, the epithelial defense of the body, as far as it concerns a tooth, is ineffective. It is no longer able to combat with the situation. The granuloma around the root end of the tooth is not an evidence of ill health. Pathologically speaking, to me it is not an evidence of ill health, but is a substitution product for the epithelial covering of the epithelial lining of the mouth. Therefore, it is not evidence of ill health, but evidence of the protective mechanism of the body.

Dr. Price: May I correct the misapprehension? Dr. Hatton understood me to say, or imply, that the presence of the granuloma was an evidence of poor health. I have tried to say, and wish to say now that I believe, as he apparently does, that the granuloma is not in itself evidence of poor health. On the contrary, it is the evidence of a good capacity to defend the host against a toxic material that is coming out of the tooth, and is therefore an evidence of good health. I wish to state that the dead policeman is no sign of a good quarantine. If that granuloma has organisms in it, it is not functioning properly, because if you lay a healthy granuloma on a petri dish with any strains of streptococcus that we have been able to find, it will not only destroy the organisms it comes in contact with, but the organisms for several centimeters around. It is, therefore, a defensive mechanism. I should like to ask Dr. Hatton if he would be willing to go on record as having it understood that he believes a root tissue of a pulpless tooth is comparable, in any sense of the word, with an infected appendix. In the former case, there is no possibility of the mechanism of defense, leukocytes, going into the structure of the tooth, but, in the case of the appendix, the vascular circulation carries them up to the line of contact, which can be anywhere, where there is an organism. That is not so

in the tooth. The tooth is an infected sequestrum, and the organisms are protected thereby, and the body defenses cannot reach them.

Dr. Hatton: I am asked as to whether or not a tooth is a sequestrum (that is, dead tissue) and whether or not the comparison between the appendix and the tooth is justified. The body has only one definite reaction to a sequestrum. It is a principle that any man who practices surgery knows that dead bone, dead mineral tissue anywhere in the body, is rejected by absorption, or it is eliminated and thrown off, absolutely and unquestionably, or it is completely encapsulated. I see any number of roentgen-ray pictures of dead teeth and reaction of the body to dead teeth, and they are sequestrums. They are foreign bodies enclosed by living tissues. One of our men brought us one the other day. A girl of 13 fell and broke off one anterior tooth and completely dislodged two others. These were removed, treated, filled and replanted. There are dead teeth, and this reaction is absolutely typical and unmistakable, and any one can identify it as a rejection of a sequestrum. I have yet to see a pulpless tooth in which there is no evidence of marked infection grossly around the root of the tooth with that type of absorption that characterizes the typically dead tooth, the replanted tooth. Toward such a typically dead tooth, the reaction of the body is entirely different from that from a pulpless tooth, and typical of the reaction of the body to sequestrums anywhere. Wherever there is a sequestrum, that reaction is typical. It is absorbed, if there are living tissues in contact. If there are not living tissues, it is completely closed with a calcified shield or if it cannot be dislodged, absorbed or enclosed, it is associated with drainage through a sinus. I know that the comparison of an appendix with a pulpless tooth is rather unfortunate. I used that only to illustrate the fact that there are parts of the body that are in intimate contact with bacteria constantly. Any histologist that studies the question knows that the connective tissues in appendixes are frequently bared as are the connective tissues in tonsils, and there is a process going on there that is essentially similar to the condition around the apex, although this illustration is unfortunate, because the appendix is not a hard tissue. Perhaps Dr. Price is justified in criticizing me for using it.

Dr. Price: Dr. Hatton's last statement gives me an excuse to ask another question. He made the statement that the absorption of the sequestrum took place by, and because of, the living cells that were in contact with it. I would like to ask if the living cells that are in contact with dead dentin are not living cells of cementum. Since that is true, how is it possible for the living cells of cementum, which are the only cells in contact with the dead dentin, to produce this function of reabsorption?

Dr. Hatton: How is the replanted tooth absorbed?

Dr. Price: That isn't answering my question at all; that is evading it.

Dr. Hatton: No, it isn't; that is the answer to it. Here is a replanted tooth—

Dr. Price: I am talking about living cementum. I am talking about a tooth that has not been extracted. The tooth you are defending has dead cementum, and you are defending it on the principle that, if it were intolerable to the body, it would be resorbed by the body. I am saying that the living tissues which take part in that process of absorption can't get to the dead sequestrum, because of the intervening layer of living cementum.

Dr. Hatton: Dr. Price evidently hasn't seen my work that has appeared in *The Journal of the American Medical Association*, THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION and perhaps in *Dental Cosmos*, where I have shown that living cells do come in contact with dentin. If the filling does not come down to the apex, the initial reaction is always a more or less stormy one. You dentists probably know that it is sometimes so stormy that you can't sleep either for one reason or another the night after you have filled it. This stormy reaction is always associated, invariably associated, with absorption of dentin. How does the absorption of dentin occur—absorption of dentin of this portion of the canal that is not filled. It occurs by the action of cells, either present in the pulp tissue that was not destroyed by the filling operation, or by cells which have passed into this opening, into this space that is left between the apical end of the filling

and the apex, along with newly formed blood vessels in new granulation tissue. I don't know what they are. They may be cementoclasts, odontoclasts or osteoclasts. They are the same type of cells that are associated with hard tissue absorption everywhere. You have absorbed out a portion of the wall of the dentin of the canal wall, that part of the wall damaged by the drug, instrumentation or whatnot, until the thing is clean, and there is a smooth surface there, and then this reaction comes to an end. Now, if that were a dead structure, if that were a sequestrum, the absorption would never stop, but would proceed from the inside of the pulp canal where there is no layer of living cementum. There is nothing there to cover the so-called dead dentin. That is the lining of this part of the pulp chamber and is formed by the denuded dentin. You have the whole scene set for complete absorption of the tooth from the apex outward, but it doesn't go on; it stops. Instead, next we have the application of the functional law or rule which says that any tissue, anything in the body, that is not useful, must undergo atrophy, but that useful structures persist. Atrophy of the pulp canal occurs, and that is achieved by the deposit of osteoid cementum until the wall is sufficiently covered, or until the diameter of the pulp canal is reduced to limits that are comparable with the needs of the situation. If that tooth were a sequestrum, you would have the stage set for a complete absorption of it by way of the apical opening, where you have so-called dead, denuded dentin. You have all the mechanism ready to reject the tooth. There is no layer of the vital cementum to protect it, but instead of absorption there is restoration. That wall of osteoid cementum completely covers every dentinal layer, and I defy any organism to escape through it. The only possibility of organisms getting into the canal is through the filling. If there are organisms in the filling, it is possible that they can get into the canal and reinfect the apex. If the apex is infected after this regeneration has taken place, it can only take place by two routes, either by way of the periodontal membrane or by way of the blood stream.

Edouard M. Hall, Kansas City, Mo.: Dr. Rickert has called attention to that group of teeth in which degenerative processes were in progress in pulps that had been encroached upon or capped. He brings to our consideration these reactions as being of a very serious nature. I believe that the clinical observation of all of us who have been working on this will verify Dr. Rickert's observation. Is the virulence a result of the acute condition, or is it due to the fact that the resistance of the patient has been reduced? Which one of these elements in the myriad of variables is most responsible for the systemic reaction? We would have to have a culture from that tooth during the stage of toleration, the presence of infection without systemic reaction, then we would have to have another group of tests run when it was in the active stage, with the secondary symptom. Dr. Hatton verified the fact that the virulence of all these cultural tests is much affected by the condition when they are taken, whether a chronic or an acute condition. I should like to ask Dr. Rickert whether he has dicovered any means other than local symptoms that will be a guide in our elimination or retention of these teeth in which deep cavities have approached the pulps. Then we come to the variable of susceptibility and immunity in the patient. Dr. Rickert has made me absolutely afraid of retaining any tooth with a deep carious cavity, especially if the patient has a systemic reaction, and we can't localize or lay the blame on another tooth, or if there are no pulpless teeth in that mouth.

Dr. Rickert: This subject of degenerated pulp is big enough to warrant all the time we have had on this whole subject. In the first place, Dr. Hall, it has been my observation that the very individuals who are highly susceptible to this type of infection are the group that Dr. Price and I would say are unsuitable candidates for any kind of root canal treatment, and are also the ones, as far as my observation goes on this subject, who are subject to these early pulp degenerations preceded by some form or other of irritation. Do you get the point I am trying to make? I don't want to give the impression that you should discontinue trying to save pulps that have been involved. We should study the patient carefully when we want to do root canal work. This is the point you must get in mind. Can you conceive of a more ingenious device that either God or man could develop to increase the virulence of organisms than that presented by a degenerating pulp—in which part of the pulp is alive and the remainder is nonvital? Here you have the carrying away of the toxic products, on

the one hand, and a continuous supply of culture mediums suitable to bacterial growths. In no case do we have a more ideal condition. You say, "How are we going to distinguish these cases from those of pulpless teeth? I couldn't go into the clinical picture, because it is a long story; besides, we have but a small amount of information on the subject as yet, other than the seriousness of the subject. We have a new problem to contend with. When you have removed all pulpless teeth, and the physician has been unable to locate any other focus of infection, and the patient is still suffering, you can very well look into some of the vital or semivital pulps that are still present. In fact, the most spectacular recoveries that I have ever observed are those in which we made a clean sweep. We have taken out all of the teeth; we didn't stop with pulpless teeth. We haven't time to observe all the clinical picture. We hope to see new symptoms that we haven't as yet discovered. We have had many cases in which the degenerating pulp has been definitely associated with some more general involvement, but the ones we have observed so often have usually been initiated first with the stiff neck and finally with certain forms of myositis. When I see those, and after all the pulpless teeth have been removed, I begin to go over the rest of them very carefully with every available test for vitality. I will just cite one case to show how we can blunder. A patient was presented to us four months ago from the health service, with arthritis of the shoulder of two months' standing. There were seven pulpless teeth. The conventional thing would have been to extract all the pulpless teeth without studying the vital ones. But the symptoms I have given you were typical, so I began to suspect a degenerating pulp, and found it in the central incisor. That pulp was removed and cultured. The patient had had arthritis of the shoulder for two months. The second day the patient was practically relieved, and the third day the arthritis was completely gone, and has remained so for four months. The patient still has the pulpless teeth. That is not saying that we are not going to treat the pulpless teeth. We inoculated rabbits with the culture from the vital pulp, and within two or three days, the front legs were arthritic and stiff, a condition close to localization. To Dr. Hall of Texas, I want to say one other word: The practical application of why you came here from Texas is a good question. Dr. Hatton was perfectly right in saying we can't answer all the questions today. Dr. Thomas B. Hartzell, six or seven years ago, wrote to all the research workers and all the operators that had been been coming to the clinics and state meetings. The operators were then showing the wonderful root canal work they could do. He wrote to both groups, saying, "Let's get together in Chicago. This is what the gentleman from Texas has asked us to do. Let us get a technic, so that the stamp of the national association may be placed on it, and the operators may have something definite." Dr. Price, Dr. Howe and I were the only men that even answered the letter. The operators that had been telling you about the wonderful work shown by the roentgen-rays, and with what precision they could reach the apices of teeth, were conspicuous by their absence. After all, it is the operator, as Dr. Hatton has told you, that must take advantage of the material we are giving and help us to develop the technic. If such a thing can be done, it is going to be the final solution to the problem. We assure you that we appreciate the unusual interest experienced at this session, and we hope that we are at least nearer a final solution of this great problem.

BLOOD URIC ACID IN RELATION TO FOCAL INFECTION*

By EMIL MUELLER, D.D.S., M.S., Chicago, Illinois

THE introduction of the simple colorimetric method for blood analysis, by Folin and Denis,[1] in 1912, has made more feasible the investigations of the problem of blood uric acid in relation to disease. The methods employed previous to that time were technically cumbersome and inaccurate. As a result, progress was almost imperceptible. The new method was simple, accurate and apparently in every way adapted to the clinical requirements. The literature on this subject since that day gives evidence of enthusiastic and extensive study. The enthusiasm is no doubt accounted for by the introduction of this new and adequate method.

The study of blood chemistry is based upon the assumption that, normally, body metabolism assumes a constant character; that the various blood constituents maintain a quite definite ratio; that disease produces a change in this normal ratio, and that the severity of the disorder should be reflected in the extent of the change produced. With some or all of the phases of this hypothesis, the literature on this subject to the present day is concerned.

The human body is undergoing a constant state of transformation; the blood, therefore, must contain, at one time or another, all of the materials which compose the body tissues, in addition to those materials which are native to the blood itself. This whole process of transformation, known under the term metabolism, is of vital interest to the blood chemist. The study of diseases is confined largely to the destructive phase of metabolism, also known as catabolism. Our present treatise deals with a substance which belongs to a group of catabolic products of the nitrogenous group. These are of both body tissue and dietary origin. They comprise by far the greater portion of the excretory products.

A review of the literature of blood chemistry of the past ten years at once reveals that progress has been largely along technical lines. The subject has, of course, been studied clinically. The literature furnishes abundant evidence of diligent study. The conclusions offered on the basis of these limited observations are too varied, the data offered too conflicting to permit of any far-reaching conclusions. Nevertheless, with respect to certain general phe-

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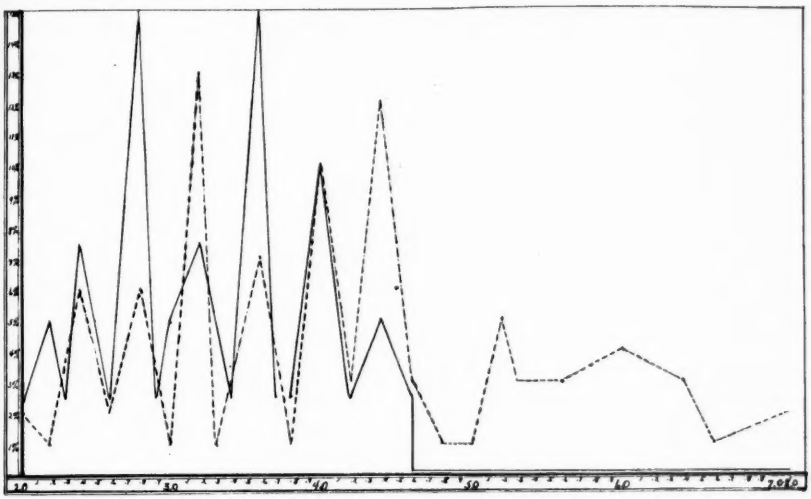
1. Folin, O., and Denis, W.: A New Colorimetric Method for the Determination of Uric Acid in Blood, J. Biol. Chem., 13: 469, 1913.

nomena, some uniformity of observation exists. It is extensively conceded that such diseases as gout, leukemia, primary anemia and nephritis are accompanied with a considerable retention of nitrogen. Of this group, uric acid nitrogen is the first to show retention, urea and ammonium salts, next. This is followed by creatinin and the undetermined nitrogen. Among medical practitioners, it is quite generally accepted today that retention furnishes an index for the early diagnosis of nephritis.



Frequency graph, showing amounts of uric acid in normal and abnormal cases. The abscissae indicate in percentages the numbers of cases of the entire number in the class represented (normals and abnormals). The ordinates indicate the amounts of uric acid in milligrams and tenth milligrams. The dotted line indicates abnormals; solid line, normals.

Uric acid is probably the most interesting of these nitrogen compounds, and it has been the basis of many uric acid diathesis theories now largely discredited. An accumulation of uric acid was held responsible for many obscure clinical conditions. Uric acid nitrogen today possesses the distinction of being the only nitrogen which the human body is incapable of decomposing. Macleod[2] states that the kidney is less competent to rid the body of this waste material than of the other nitrogen products. This interesting history, coupled with the observation that uric acid is the first factor to show retention, is responsible for the extensive study that has been allotted to this compound from the time its existence was first demonstrated to the present day. Although present in the blood in very limited quantities, it assumes a rôle of no small magnitude. If accumulation of uric acid is of as much significance as the numerous observers would have us believe, it occurs to us a matter of con-

2. Macleod, J. J. R.: Physiology and Biochemistry in Modern Medicine, Ed. 1, St. Louis, Mo.: The C. V. Mosby Company, 1918., p. 529.

siderable importance that we ascertain just what constitutes a normal and what a pathologic variation. In spite of the extensive study of uric acid, the literature is very vague on this phase of the subject. Judgment based solely upon fragmentary references encountered in our study of the records leads us to accept a rather wide variation for normals. Modestly stated, it varies approximately within the limits of from 1 to 3.5 mg. per hundred cubic centimeters of blood, and at times it is much higher. As early as 1913, Folin and Denis[3] concluded that the majority of normals varied between 2 and 3 mg. and that no pathologic significance could be attached to anything below 4 mg. Weston[4] found a great diversity as to normals in using the different tests on the same specimens. With the Folin and Denis method, his variation extended from 0.7 to 3.7 mg.; with the method of Myers and Fine, from 1 to 2; with that of Hawk, from 1 to 3, and with the method of Gettlers, from 1 to 3.5 mg. The new method of Benedict[5] gives slightly higher levels. In this connection, Dr. Markwald[6] expressed his conviction that, with the new method of Folin,[7] normal values between 2 and 5 mg. are obtained, certainly between 2 and 4.5 mg. This list is representative of current opinion. Such diversity of opinion intimates that the subject is still controversial.

Numerous hypotheses have been advanced with the effort to explain the source of uric acid. The foremost of these ascribes to the bulk of the uric acid a nuclear origin. It is believed to be derived from nuclei of cells of food, from disintegrating cellular matter of the organism and from the nuclei of dead leukocytes. The nuclei contain nucleic acids, which are highly complex substances, and, when broken up and digested, form a series of compounds variously known as purin bodies. According to Jones,[8] some of these, the oxypurins, are acted upon by the xanthin oxidase of the liver and oxidized into uric acid. Some of these, the oxypurins, escape unoxidized into the urine, since this ferment is present only in the liver. The uric acid derived from the cells of food is referred to as exogenous in origin, that derived from cells of the body or dead leukocytes as endogenous in origin. Any one of three factors, or a combination of any of the three, is concerned in an increase of uric acid. The first, and probably the most important, is impaired kidney function; second, variation in diet; third, body cell destruction resulting from various diseases.

The literature covering the subject of blood uric acid and its relationship to focal infection diseases is very limited. It offers but one study. The results obtained and the conclusions offered in this early study are so startling and the subject is of such importance that it deserves further investigation.

3. Folin, O., and Denis, W.: Protein Metabolism from the Standpoint of Blood and Tissue Analysis, J. Biol. Chem., 14: 29, 1913.

4. Weston, P. G.: Analyses of Blood of Insane Patients, Arch. Neurol. & Psychiat., 3: 147 (Feb.) 1920.

5. Benedict, Stanley R.: The Determination of Uric Acid in the Blood. J. Biol. Chem., 51: 187, 1922.

6. Personal interview.

7. Folin, O.: A System of Blood Analysis, J. Biol. Chem., 54: 154 (Oct.) 1922.

8. Jones, Walter: Nucleic Acids, Ed. 2, New York, Longmans, Green & Co., 1920, p. 70.

This study is the work of De Niord and Bixby.[9] These investigators have published their observations on twenty-one patients, apparently suffering from focal infection diseases. With uric acid determination on the blood before, during and after proper treatment, they were able to state whether their patients were suffering from one or several foci of infection, or whether they were entirely cured. Their success was 100 per cent. On the basis of these successful but limited observations, they concluded that uric acid "furnishes a reliable index to the complete elimination of foci of infection."

These writers constantly refer to normal range as if it were something specific. They do not enlighten us as to what they consider such a range. Since they have preferred to omit this essential we shall take the liberty to determine it from their report. In taking their last "recovered" figures on the twenty-one patients, we obtain an average normal of 1.47 mg. per hundred cubic centimeters. Close examination reveals that these vary between 1.20 and 1.70 mg., a limit of variation of 0.5 mg. The narrowness of this range of variation is quite remarkable, since it differs so radically from what is widely accepted as normal. In view of the fact that the making of a diagnosis, based upon uric acid findings alone, presupposes our ability to recognize what constitutes a normal, and since these workers apparently have a means for differentiating these, a discussion of the matter should hardly have been neglected. Mention, at least, of the method employed might have facilitated matters some.

9. De Niord, N. R., and Bixby, J. B.: Studies in Focal Infection, J. Lab. & Clin. Med., 7: 573 (July) 1922.

As remarkable and as startling as these findings are, we have no reason for questioning them. We are inclined to doubt the rather hasty and far-reaching conclusions based upon these limited observations, especially since their work differs so remarkably from anything hitherto recorded. In consequence of this anomalous situation, it is our pur-

TABLE 1.—URIC ACID CONTENT IN NORMAL (CONTROL) CASES

No.	Age	Sex	Uric Acid
			Mg.
1	46	M	2.80
			2.50
			3.80
			4.00
2	24	M	2.40
			3.63
3	30	M	2.80
			3.63
			2.56
4	22	M	3.60
			4.40
5	38	M	2.64
			2.80
6	21	M	4.20
			3.70
7	22	M	3.20
			3.32
8	28	F	3.60
			3.00
9	21	F	2.08
			2.80
10	23	M	2.96
			3.04
11	22	M	3.20
			3.32
12	22	F	2.20
13	24	M	3.60
14	26	M	3.40
15	34	M	2.80
16	19	M	2.30
17	20	M	4.00
18	23	M	2.40
19	20	M	2.20
20	27	M	4.00
21	22	M	4.44
22	21	F	3.60
23	40	M	4.00
24	24	M	2.44
25	21	M	2.80
26	28	M	3.20
27	34	M	4.60

TABLE 2.—URIC ACID CONTENT IN ACUTE CONDITIONS.

No.	Age	Sex	Present Complaint	Uric Acid Mg.
28	17	M	Abscess of the tongue	4.60
				3.80
29	26	M	Peritonsillar abscesses	5.30
				3.60
30	25	M	Fracture with infection;	4.00
			positive Wassermann reaction	2.00
				2.84
31	25	M	Peritonsillar abscesses	3.20
				2.80
32	23	F	Peritonsillar abscesses	5.30
				4.00
33	44	M	Fracture with infection	4.80
				3.60
34	52	M	Extensive infection following extraction	3.40
				3.20
35	26	M	Adenitis of the neck	6.60
				2.42
36	27	M	Submaxillary cellulitis; positive	5.68
			Wasserman reaction	5.32
37	44	M	Swelling of the neck	4.00
				4.00
38	44	M	Pyorrhea	4.68
				4.00
39	24	F	Impacted third molar, with infection	4.44
				2.60
40	37	M	Osteitis of the mandible	4.40
				4.00
				6.10
41	50	M	Erysipelas; carcinoma of the antrum	5.32
				6.00
42	50	M	Fracture of mandible and laceration of the face	4.40
				5.60
43	17	M	Fracture of the mandible with infection	4.40
				3.20
				5.30
44	25	F	Gunshot wound of the neck; positive Wassermann reaction	2.80
45	28	M	Fracture of maxilla with infection	2.84
46	28	M	Mandibular fracture with infection	3.32
47	9	F	Alveolar abscesses	3.20
48	32	M	Infection following extraction	4.20
49	57	M	Teeth with multiple areas of infection	4.40
50	38	M	Mandibular fracture with infection	4.00
51	20	M	Swelling of submaxillary region	3.60
52	73	M	Infection of lower lip	3.20
53	41	M	Gunshot wound	4.00
54	30	M	Infected mandibular fracture	4.40
55	14	M	Alveolar abscess of upper first molar	3.60
56	25	F	Peritonsillar abscess	4.00
57	26	M	Alveolar abscess	3.60
58	26	M	Alveolar abscess	4.40
59	59	M	Suppurating fracture of mandible	3.60
60	31	M	Cellulitis of the neck	3.08
61	41	M	Mandibular fracture with infection	2.80

TABLE 3.—URIC ACID CONTENT IN CHRONIC CONDITIONS.

No.	Age	Sex	Present Complaint	Uric Acid Mg.
62	54	M	Chronic lymphatic leukemia	2.40
				3.60
				3.20
				5.00
				2.80
				2.50
				2.60
63	30	F	Chronic cystitis; anemia	2.00
64	23	F	Middle ear infection; numerous secondary infections	3.20
				3.32
65	36	M	Alveolar abscesses; headaches	2.80
				2.96
66	66	F	Arthritis of fifteen years' standing	4.60
				4.44
67	27	M	Third molar infection	4.40
				3.80
68	62	M	Syphilitic mouth lesions; positive Wassermann reaction	6.00
				3.20
69	25	M	Staphlococcus infection of one kidney	6.40
				4.44
70	25	M	Teeth with multiple areas of infection	6.00
				4.68
71	26	M	Molar with area of infection	5.20
				4.00
72	30	M	One infected molar with fistula; positive Wassermann reaction	6.40
				4.68
73	30	M	Headaches; skin eruptions; teeth with multiple infections	3.20
				2.58
74	38	F	Infected teeth; rheumatism	4.20
				3.63
75	20	M	Submaxillary abscess; bad teeth; rheumatism	5.60
				4.20
76	28	M	Teeth with multiple areas of infections; iritis	4.40
				3.32
77	52	F	Ulcer and abscess of left molar region	6.00
78	42	M	Antrum infection	6.40
79	35	F	Sinus infection	3.60
80	82	M	Renovascular diseases	5.20
81	23	M	Area of infection, bicuspid	4.40
				4.20
82	15	M	Apical abscess with extensive necrosis	5.20
				5.30
				4.00
83	26	M	Arthritis of the shoulder and neck; numerous diseased teeth	2.20
84	40	M	Pyorrhea; syphilitic, twenty-two years	3.20
85	60	M	Arthritis of lower limbs; teeth showing numerous areas of infection	6.00
86	34	M	Apical abscesses associated with systemic disturbances	8.00
87	30	M	Teeth with numerous areas of infection	5.60
88	25	F	Sinus infection	5.20
89	61	F	Extensive pyorrhea	8.00
90	26	F	One tooth with an area of infection	2.40

No.	Age	Sex	Present Complaint	Uric Acid Mg.
91	53	M	Diseased tonsils	4.00
92	69	M	Multiple areas of infection; rheumatism	4.44
93	22	F	Infected areas associated with teeth	3.20
94	50	M	Numerous infected teeth; arthritis	3.80
95	42	M	Pyorrhea; arthritis	3.60
96	25	F	Numerous infected teeth; headache	3.20
97	22	M	Inflammatory rheumatism	3.60
98	29	F	Teeth with numerous areas of infection; anemia	2.40
99	40	M	Arthritis associated with infected teeth	2.80
100	60	M	Pyorrhea and arthritis of 2 years' duration	4.44
101	22	M	Ulcerative gingivitis	5.20
102	24	F	Peritonsillar abscesses	3.20
103	45	M	Infections of upper second and third molars, with fistulous opening	2.40
104	31	M	Alveolar abscesses	2.40
105	29	M	Tuberculosis of the tongue	5.00 5.20
106	25	M	Extensive abscess on the molar	2.80
107	40	M	Necrosis with infection, in the lower first molar region	3.60
108	25	M	Mandibular fracture with chronic infection	4.20
109	40	M	Arthritis; infected teeth	2.60

TABLE 4.—URIC ACID CONTENT IN UNDETERMINED GROUP

No.	Age	Sex	Present Complaint	Uric Acid Mg.
110	68	M	Carcinoma of the mandible; roentgen-ray burns	2.40 2.20 3.20
111	45	M	Carcinoma of the antrum removed; roentgen-ray burns	2.00 2.40
112	45	M	Suppurating carcinoma of the mandibular region	4.40 4.20
113	69	M	Carcinoma; pyorrhea	4.00 3.60
114	13	M	Giant cell sarcoma, lower first molar region, of five months' duration	3.20 2.40 3.63
115	76	M	Rodent ulcer of the upper lip	4.00 2.40 3.63
116	13	M	Harelip	3.44 2.66 3.80
117	19	M	Fracture of the mandible, uncomplicated	3.40 2.66 2.60
118	22	M	Cyst of the neck	4.00 4.20
119	14	M	Cyst, upper maxillary region	3.20
120	50	F	Exophthalmic goiter	3.20
121	30	M	Large cysts, lower third molar region, of three months' duration	2.64

pose to test the validity of these conclusions, by following out a similar line of experiments, extending over a wider range of cases and including a group of normal cases, and to draw such conclusions as our observations will reasonably justify.

The present investigation was undertaken with the view of obtaining further data as to the diagnostic and prognostic value of uric acid with regard to focal infection diseases. At the outset, it was hoped to confine the study strictly to patients suffering from focal infection diseases. Early irregular findings at once showed the fallacy of this policy. The necessity for widening the scope of this research became at once manifest. Since diagnosis with uric acid is essentially a work of comparison based upon normal findings, and, since the literature is destitute of comprehensive studies of normal individuals, it was felt that a better basis for comparison was needed, this to be obtained from a diverse study of normal and abnormal conditions as they prevail at large. It was further considered desirable in view of the fact that we employed an entirely new method, which gives readings somewhat higher than any methods previously employed. The method that we have chosen for our work is that of the well-known blood chemist, O. Folin.[7]

We obtained a quite diversified group of subjects for our experimental work from among the patients of the Northwestern University Dental School clinics, from the student body of the same school and from the Cook County Hospital. One hundred and twenty-one different people served as subjects for our experiments, and a total of 191 blood analyses were made. Frequently, from here on, we will use the term abnormals. Whenever employed, it refers to all of those of our patients that could not be strictly classed as normals. For convenience of study, we have divided our patients into groups; viz: (1) normals; (2) acute; (3) chronic, and, lastly, an undetermined group. Under the first group, we listed all those patients that were distinctly healthy, under the second, those whose conditions were acute; third, those whose conditions were chronic, and under the undetermined group all of those of our patients who could not properly be listed in the first three classes. We are conscious of the shortcomings of this classification, which was selected more for convenience than for scientific accuracy.

The tables corresponding to the classes enumerated furnish brief histories, including the results of our uric acid determinations. Close scrutiny discloses considerable variation for the uric acid findings of both normals and abnormals. No line of demarkation is evident. Viewed purely from a mathematical standpoint, the averages obtained are as follows: normals, 3.21 mg., all of the abnormals together, 4.08. For each of the abnormal classes, the averages are: 4.10 for the acute, 4.27 for the chronic, and 3.32 for the undetermined group. Diagnosis is intrinsically an individual matter; consequently, averages are of little value. We must therefore resort to other means for a clearer conception as to the exact nature of these variations. To facilitate this, we have prepared a graphic chart, which sets forth the distribution very accurately. The distribution of the forty-one tests carried out on twenty-seven normal patients is illustrated by black line *A*. Dotted

black line *B* shows the exact manner of distribution of the first tests of each of the ninety-five abnormal patients, but even this chart fails to bring out any marked contrast. Studying the normals we find all but one of the forty-one normal tests within the limit of 2-4.50 mg. Examination of the distribution of the abnormals shows that sixty-nine of the ninety-five fall within this normal limit, and twenty-six outside or above that limit. Quite obviously, according to our observations, no pathologic importance can be attached to anything below 4.50 mg. and probably not below 5.00 mg. Any increase beyond that point may be of positive pathologic significance.

Before we proceed with a more detailed discussion of our various groups, we will digress to introduce our readers to a factor that we believe has tremendous bearing on the subject matter to follow. We have in mind the question of diet, or feeding. The preponderance of clinical judgment inclines to the belief that the effects of nuclein-rich diet or uric acid excretion reaches its maximum within three to four hours after consumption. In consequence of this belief, most investigators have, before collecting blood specimens, imposed dietary restrictions on their subjects extending over periods of hours, with the hope of escaping such variation. Today, we have positive evidence that such meager regulation or restriction has most probably magnified rather than minimized the error. Rose,[10] in an extensive research, covering a period of about five years, has demonstrated that the greatest effect of a nuclein rich diet on uric acid excretion manifests itself the day following such consumption, and that variation in purin-free diet produces similar changes. In addition, he has found that any abrupt alteration in food consumption produces increasing and decreasing effects on uric acid excretion, which gradually return to normal. Lewis and Corley[11] have similarly demonstrated that uric acid excretion can be increased with purin-free diet. These studies clearly indicate that, if blood specimens are to be obtained, unaffected by dietary fluctuation, we must not only exercise prolonged control over the protein-rich diet of the patient, but we must also know as well the nature of the effects of the nuclein-free diet which we are prescribing. At the present time, the subject is too little understood for us to be able to exercise intelligent control. Therefore, for our work, we have dispensed with dietary regulation in all but a few instances, which we will discuss in detail. The studies referred to deal with the effects of diet on uric acid excretion. We believe that the observations of these investigators are directly applicable to our work, since all the excreted uric acid is derived by the kidneys from the blood. Both of these studies, in reality, are studies on the influence of food on endogenous purin metabolism. We have conducted a few brief experiments for the purpose of demonstrating that the application of the observations of these workers to our problem has a legitimate basis.

With Nos. 1, 2, 3, and 4 of our normals, we performed preliminary tests with the view to obtaining the normal

10. Rose, W. C.: The Influence of Food Ingestion upon Endogenous Purine Metabolism. I-II., J. Biol. Chem. 48: 563-575 (Oct.) 1921.

11. Lewis, H. B., and Corley, R. C.: Studies in Uric Acid Metabolism, J. Biol. Chem., 55: 383 (March) 1923.

levels for these individuals. With No. 1, two preliminary tests were made; with Nos. 2, 3 and 4, only one test was made for each. Three hours before the succeeding determination, each subject was given a nuclein-rich diet. No. 1 showed an increase from 2.50 to 3.80; No. 2, from 2.40 to 3.63; No. 3, from 2.80 to 3.63, and No. 4, from 3.60 to 4.40. Stated on a percentage basis, No. 1 increased 52 per cent; No. 2, 50 per cent; No. 3, 47 per cent, and No. 4, 22 per cent. With No. 1, the morning following consumption of the rich protein diet, an additional increase of 5 per cent was observed. These results seem to indicate that a nuclein-rich diet has considerable effect on uric acid metabolism, that uric acid output can be increased with food, and that the effects probably extend over a considerable period of time. Our observations are in complete harmony with the more extensive findings of Rose[10] and others.

While we made no attempt at dietary regulation beyond that of the experimental work just referred to, we believe that we have been able to collect most of our blood specimens under quite uniform conditions. All of the specimens for our normal determinations were taken from students none of whom are in the habit of eating anything but light lunches. Most of these were taken in the afternoon. Fully two-thirds of our blood specimens from abnormal cases were obtained from patients of Cook County Hospital. These were nearly all taken in the morning. For the remainder of our subjects we have no such conditions. The only question addressed to these was as to whether they had consumed heavy lunches or not. The findings of these differed, when separated from the others, in no appreciable degree, so that we considered separate discussion on that account unnecessary. In the remainder of our normal cases, we performed tests with a view to obtaining data on normals as they prevailed under uncontrolled conditions. With Nos. 5 to 11, inclusive, second tests were made to determine whether normals varied extensively under similar conditions. Our results disclosed considerable variation. We believe diet to be responsible for this constant fluctuation. While the fluctuations of normals, as ordinarily obtained, were not so great as when deliberate feeding was undertaken, the daily variations, as indicated by our observations, are considerable. The original idea of Burian and Schur,[12] still maintained by many today, that excretion of endogenous purin in the same individual is constant day by day is contrary to our observations. As early as 1905, Folin[13] observed that variation in purin-free diet produces changes in uric acid excretion, which fluctuated inconsistently with the dietary changes. Abundant evidence is available to discredit that old but still widely accepted idea.

In our effort to find an explanation as to the cause of normal variations resulting from diet, we find it referred to many hypothetical sources. Smetanka[14] attributed it to nuclear disintegration of the glands of the alimentary canal occasioned by the process of

12. Burian, R., and Schur, H.: Ueber die Stellung der Purinkörper im menchlichen Stoffwechsel, Arch. Ges. Physiol., 87: 239, 1901.

13. Folin, O.: Laws Governing Chemical Composition of Urine, Am. J. Physiol., 13: 66, 1905.

14. Smetanka, F.: Sur Herkunft der Harnsäure beim Menschen, Arch. Ges. Physiol., 138: 217, 1911.

digestion. Mares[15] and Lambling and Dubois[16] hold similar views. Umeda[17] concludes that it is due to synthesis of purins from carbohydrates. Harding and Young[18] believe it to be due to synthesis from arginin and histidin. The more likely theory is that suggested by Lewis, Dunn and Doisy,[19] which ascribes the variation as being the result of general stimulation of cellular metabolism by amino-acids or their catabolic derivatives. That variation in food consumption results in variation of uric acid production and excretion is rarely disputed; but the most likely cause for such variation is a matter of considerable controversy.

The first group of our abnormal subjects under Table 2 comprises thirty-four patients, all of whom manifested acute symptoms. With the majority of these, the symptoms were quite marked. The first twelve patients, Nos. 28 to 39, inclusive, are those of this group that showed more or less decrease in uric acid retention after treatment. Of special interest are Nos. 36 and 37. No. 36 had a diffuse cellulitis of the neck, of several days' duration. Uric acid determination showed 5.68 mg. Ten days later, this condition had apparently cleared up. The uric acid findings now showed 5.32, no appreciable decrease. This patient had a positive Wassermann reaction, which probably accounts for the failure of the uric acid to return to lower levels. Still we have on record several other cases, notably two, that showed little or no retention—Nos. 44 and 84. No. 44 appeared at the hospital with an acutely infected gunshot wound of the neck, a positive Wassermann reaction, and a uric acid content of 2.80. No. 84, who had had syphilis for twenty-two years, had a severe case of pyorrhea and a uric acid content of 3.20. No. 37, referred to above, had an acute swelling of the neck, of tonsillar origin. Uric acid determination yielded 4.00. Three weeks later, when the condition had been fully cleared up, another uric acid determination was made, with the same results.

To revert to No. 36, we must assume, on the strength of the last uric acid findings, that this patient is still afflicted with some disorder. Hypothetically, one of two conditions is present: either this patient is afflicted with some systemic malady which is resulting in an increased uric acid output that the kidneys are unable to excrete, or there is present a subnormal kidney activity, which may be the result of temporary obstruction, primary or secondary infection of the kidneys, and, in consequence, retention without increased formation. The former hypothesis is the one upon which our predecessors, De Niord and Bixby,[9] have explained their findings. It is based upon the widely prevalent belief permeating our textbooks and periodical literature that the kidneys normally excrete any abnormal amount

15. Mares, F.: Sur l'origine de l'acide urique chez l'homme, Arch. Slov. Biol., 3: 207, 1887.

16. Lambling, E., and Dubois, F.: Sur l'origine des purines. endogenes, Compt. rend. soc. biol., 76: 614, 1914.

17. Umeda, N.: Influence of Fats and Carbohydrates on the Excretion of Endogenous Purine in the Urine of Dog and Man, J. Biochem., 9: 421, 1915.

18. Harding, V. J., and Young, E. G.: Placental Feeding and Purine Metabolism, J. Biol. Chem, 40: 227, 1919.

19. Lewis, H. B.; Dunn, M. S., and Doisy, E. A.: Studies on Uric Acid Metabolism, J. Biol. Chem., 36: 9, 1918.

of uric acid with difficulty. Our observations in quite a number of cases indicate the reverse to be true. With the former hypothesis, let us attempt to explain the findings of Nos. 44 and 84. In both of these cases, we are positive of increased cell destruction, and therefore, increased uric acid formation, but on examination, we find the uric acid retention comparable to our lowest normals. What has become of the additional uric acid? Apparently the kidneys have eliminated it.

With patients Nos. 40, 41, 42 and 43, the uric acid levels fluctuated with the patients' conditions. All of these became progressively worse, as the uric acid indicates.

The remainder of the patients of this class manifest no unusually high uric acid findings. At any rate, none disclosed retention above the normal level. Of special interest are Nos. 45, 46 and 61. All three of these subjects displayed very acute symptoms; still, their uric acid findings are among our lowest. We can account for this fact only upon the basis of marked kidney activity. Patients Nos. 29, 31 and 32 entered the hospital with acute peritonsillar abscesses. Their uric acid levels were 5.30, 3.20 and 5.30 mg., respectively. Two days after operation, these patients showed changes as follows: No. 29 had decreased from 5:30 to 3.60 mg.; No. 31, from 3.20 to 2.80 mg., and No. 32, from 5.30 to 4.00 mg. Whether these reductions were due entirely to the sudden clearing up of their conditions or whether they are partly accounted for by the fact that these patients were unable to consume much food, we are unprepared to state.

In Class 3, which includes all of our chronic cases, we find both extremes of retention. Nos. 86 and 89 represent the upper extreme, with a uric acid retention of 8 mg. each. These may have been still higher. With the standard employed, this was the maximum that could be read with accuracy. Both of these patients were obtained at the school clinic, and unfortunately could not be induced to return for further study. Since their uric acid readings are distinctly outside the normal limit, we assume that, in these cases, they are of positive diagnostic value.

It is a popular conception of workers in this field that roentgen-ray and radium therapy, as well as such diseases as leukemia, anemia and cachexia, always produce a high uric acid content. This is merely an assumption, not based upon any study but purely upon accidental observation. Our data, while limited, are sufficient to cast doubt on the validity of that assumption. We have four cases, Nos. 62, 63, 64 and 65 of Class 3, that are of interest in this connection. No. 62, a patient suffering with chronic lymphatic leukemia, was studied for a period of eight weeks. One uric acid test was made each week for seven consecutive weeks. The first test yielded 2.40 mg., and the white cell count was 27,000, with a marked predominance of lymphocytes. The white cell count varied between 27,000 and 30,000 throughout our observation. The second week the uric acid test was 3.60 mg.; the third week, 3.20. Three hours before the test, the fourth week, the patient was given a nuclein-rich (liver) diet, with a resulting uric acid of 5.00 mg. The fifth week, the uric acid test showed 2.80 mg. One hour before the test, the sixth week, the patient again consumed liver, with no apparent effect. The test indicated 2.40 mg. The last and final test yielded 2.60 mg. This patient gave a

history of loss of weight, and had numerous teeth with large areas of infection. With this patient, we most assuredly have evidence of nuclear degeneration. It should be mentioned that he was not undergoing treatment before or during the time of our experimentation. No. 63 was an anemic patient that had suffered for years with chronic cystitis. The uric acid test showed 2.00 mg. Patient No. 64, also an anemic, has had a chronic middle ear infection for eighteen years; was suffering from numerous secondary foci of infection, and was subject to quinsy. Radiograms disclosed numerous areas of infection about the teeth. The uric acid finding was 3.20 mg. After the first test, all of the pulpless teeth were removed. Marked systemic reaction followed every extraction. Some time after all of the suspicious teeth had been removed (this was about two months after the original test), another test was made, which indicated 3.32 mg., a slight increase. This variation probably represented the ordinary fluctuation and was of no significance. With this patient, there was increased cell destruction. Where was the additional uric acid to be found? Some of it, possibly, may have been reutilized; most of it was no doubt being eliminated. No. 65 had been suffering with headaches, which resulted from numerous alveolar abscesses. The uric acid level was 2.80 mg. Six weeks later, when the condition had entirely cleared up, the uric acid test showed 2.90. We can account for it only upon the basis that normals and abnormals both are constantly fluctuating. We believe that there was no retention in this case, but that the uric acid was readily excreted. Nos. 83, 95, 97, 99 and 108 were all patients suffering from some chronic foci of infection. These were like many others thus far referred to. We had positive evidence of nuclear degeneration, and they should have shown uric acid retention, but none was evident. We have no reason for assuming that these uric acid findings were anything but normal, since they were distinctly within the normal range.

Nos. 110 and 111 of the undetermined group are conspicuous examples of lack of uric acid retention after the use of roentgen-ray treatment. No. 110 had a carcinoma of the mandible removed. Heavy doses of roentgen ray developed an inflammation of the mandibular nerve, which had to be resected. During the time of roentgen-ray treatment, two tests for uric acid were made at separate intervals. The first showed 2.40 mg., the second, 2.20 mg. Sometime after the patient had left the hospital, the uric acid indicated a rise to 3.20 mg. No. 111 had been receiving heavy doses of roentgen-ray after the removal of a carcinoma of the antrum. This patient died from metastasis. During the time of roentgen-ray treatment, this patient had a uric acid content of 2.00, and, later, of 2.40 mg. Nos. 112 and 113 also received roentgen-ray and radium treatments. These cases were more advanced, and their uric acid content was also higher, as indicated in Table 3. As Nos. 114, 115 and 116 had only minor operations performed, these patients really never were sick. We studied their uric acid level with the view to obtaining the effects of hospital diet on patients. Tests were made at the time of entrance, after the patients had been at the hospital for several days, and, again, sometime after they had left the hospital. No. 114, on entrance, showed 3.20 mg.; later, 2.10 mg., and, after

leaving, 3.80 mg., No. 115 had 4.00 mg.; later, 2.40 mg., and 3.63 mg. after leaving. No. 116 had 3.44 mg.; later, 2.66 mg., and, after leaving, 3.80 mg. In view of the fact that these patients were at no time sick, we account for these fluctuations on the basis of the lighter diet received at the hospital. No. 117, who was a patient with an uncomplicated fracture of the mandible, showed 3.40 mg. on entrance, and 2.70 and 2.60 mg. two distinct times while in the hospital. This patient was able to consume only liquid food; so the drop here noted was without doubt to be explained upon the basis of diet. We assume also that the rise noted with No. 45 after leaving the hospital can be attributed to diet. We have observed similar tendencies following changes to hospital diet. None were so clean cut as those just referred to. In the main, our results are quite different from what was expected at the outset. Of necessity, the data for this study had to be collected within a period of about three months. Quite obviously, this fact leaves our work open to certain criticisms that might have been obviated with more prolonged study. More attention might also have been devoted to our elucidation and presentation of tables. It is doubtful that anything would have been gained from so doing. Sufficient information has been given to enable our readers to follow intelligently the ensuing summary and conclusion; or, if the readers choose, it places them in a position to analyze the findings for themselves in any way they may desire. We might mention that this point of the work was arrived at without any definite idea as to what the observations would show. No analysis was made until the work of observation was completed. It is believed that, in this way, the pitfalls of preconceived ideas have been avoided.

In our work, we made frequent use of the writings of such eminent workers as Van Slyke, Benedict, Myers, Folin, Wu, Denis, Macleod and Rose. Our observations with 121 patients, plus the ideas obtained from such foreign sources, constitutes the sole basis for our discussions and conclusions.

Before we make any attempt at crystallizing our observations, it is desirable that we briefly summarize the facts of our experiments that we wish to emphasize:

1. The normals varied between 2 and 5 mg.

2. The uric acid content in about 70 per cent of the abnormals of our observation fell within the normal range.

3. The abnormals within the normal range could not be differentiated from the normals with the uric acid test alone.

4. Removal of the foci of infection with some patients was followed by a decrease in uric acid content.

5. Some patients suffering conspicuously with one or numerous foci of infection showed no retention.

6. Heavy doses of roentgen ray and such diseases as leukemia and anemia were not always accompanied with retention of uric acid.

The widely accepted theory that kidney activity in uric acid excretion has a definite limit is not borne out by our observations. The prevailing theory fails to account for the many variations that we have encountered in our study. Our experiences can be adequately accounted for only upon the hypothesis

that attributes functional capacity to the kidneys much in excess of the normal demands. We have adopted this hypothesis in obedience to the evidence presented. In our estimation, the former hypothesis fails because it leaves no room for an explanation for the lack of retention in those extreme case, Nos. 44, 45, 46, 61, 62, 63, 64, 65, 83, 84, 95, 97, 99, 108, 110 and 111, in which we have positive evidence of increased uric acid formation. If it is assumed to be a characteristic tendency for the kidneys to excrete uric acid with difficulty, this tendency should be consistently and unfailingly present. We have furnished good evidence that such is not the case. The supposition that our observations are a matter of pure chance is rendered improbable by the large number of cases encountered. We believe that, under normal conditions, the kidneys excrete any amount of uric acid without any difficulty. When any persistent retention does occur, it indicates abnormally functioning kidneys, or, in other words, indicates a degree of nephritis. That such is the case is rendered more probable by the study of Czoniczer,[20] who, from a thorough study of more than a hundred patients, concluded that retention, exclusive of that occurring in leukemia, anemia, and roentgen-ray therapy, signified renal insufficiency, the amount of retention indicating approximately the severity of the disease.

The assumption that attributes increased capacities to the kidneys appears to us preferable, since it is the more scientific, because it is in harmony with our conceptions of the adaptive capacities of various parts of the human body. The lungs, heart, liver, stomach, kidney, etc., are, in emergencies, capable of doing more work than is normally demanded of them. If the demands on these parts are persistently high, they will undergo structural enlargement that will enable them to meet these increased demands without difficulty Ashoff[21] cites cases wherein, after disease or removal of one of the kidneys, the remaining kidney has undergone sufficient enlargement to dispense the work of two kidneys with no apparent difficulty.

CONCLUSIONS

1. Uric acid is present in the blood of every normal individual.

2. The amount of uric acid content in normal subjects varies through a considerable range.

3. There is no sharply defined line between normals and abnormals.

4. According to our experience, anything above 5 mg. probably indicates a pathologic process.

5. Any increase over the normal limit, if persistent, indicates subnormal kidney activity, which may be the result of a temporary obstruction, or of a primary or secondary infection of the kidneys.

6. Retention is a positive diagnostic factor in focal infection diseases only when a primary lesion in the kidneys can be demonstrated not to exist.

20. Czoniczer, G.: Die Rolle der Blutharnsäurebestimmung in der Diagnose und Prognose der Nephritiden, Arch. klin. Med., 140: 289, 1922.

21. Aschoff, L.: Lubarch-Ostertag, Ergebn d. Allg. Path., 5: 67, 1898.

A METHOD OF PREDETERMINING TOOTH MOVEMENT AS AN AID TO THE DIAGNOSIS AND TREATMENT OF MALOCCLUSION*

By JOSEPH E. JOHNSON, D.D.S., Louisville, Kentucky

IT is unnecessary for me to go into the history of arch predetermination, as I am sure all are acquainted with the work that Hawley, Stanton, Gilpatric, Hoggan and Hanau have done along this line. I shall therefore take up the different steps in the technic of the method I am about to demonstrate.

Figure 1 is a front and side view of the trays used in taking the impression. These trays are very shallow, having just enough depth to cover about two-thirds of the crowns of the teeth. Impression tray compound is used to take the impression. (Fig. 2.) I find that this compound sets more quickly, gives sharper lines and pulls less than any other.

The following technic is used in its manipulation: The compound is heated in water until it is quite soft. The tray is also heated so that the compound will adhere to it. The compound is then placed in the tray, the back of which is passed under a stream of cold water. Then the compound is passed through a Bunsen burner flame until it is soft, then is inserted in the mouth, and the impression is taken in the usual way. I have found it necessary to use this technic; otherwise, a poor impression will result in the upper on the lingual; for, since there is no palate in the tray, the compound will flow away from the teeth. I take a wax bite, that is, I have the patient bite into a piece of baseplate wax, and I also measure the distance between the head of the condyle and the mandibular central incisors.

The median line is registered at this time, the appliance shown in Figure 3 being used to obtain it. This consists of a headgear and frame. The latter is held in position on the face by means of a set screw on the headgear. At the top and bottom of this frame are adjusting screws, to the ends of which is attached a fine wire. A small rod in the middle of the frame prevents the wire from pressing on the nose. To obtain the median line, the fine wire is moved back and forth by means of the screws, until it is in the middle of the face. (Figure 3, right.)

The patient is then instructed to throw the head back, as in Figure 3, left. If the wire passes along a line between the central incisors, we know

*Read before the Section on Orthodontia and Periodontia at the Sixty-Seventh Annual Session of the American Dental Association, Louisville, Ky., Sept. 23, 1925.

the median line is correct. If it does not, the median line is marked on the tooth with a pencil and the difference

Fig. 1.—Front and side views of tray, showing depth.

is measured with the dividers and registered on a cork mat.

Since we need only the crowns of the teeth, the next step is the cutting down of the impression. This is done by means of a wood file or an ordinary

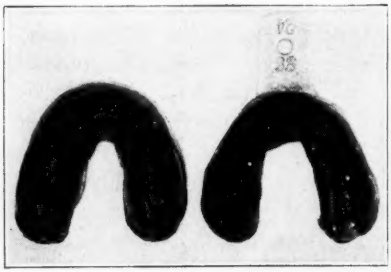


Fig. 2.—Modeling compound impression before trimming.

grater (Fig. 4). I prefer the wood file.

Figure 5 shows the impression after the teeth have been cut down. It will be noticed that the position of each

Fig. 3.—Appliance to find median line.

tooth has been marked on the compound. This is done so that, when the

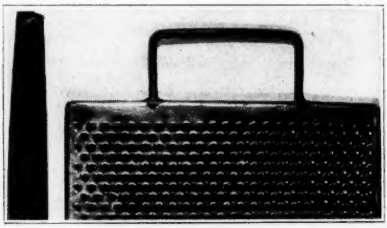


Fig. 4.—Wood file and grater used to cut down modeling compound impression.

impression is packed with amalgam, we are able to place the pins in the proper

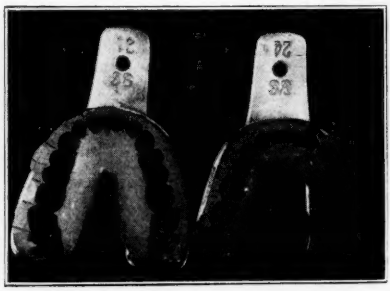


Fig. 5.—Modeling compound impression cut down and ready to be packed with amalgam.

place in the amalgam teeth. It takes from one-quarter to three-eighths ounce of amalgam to pack an impression.

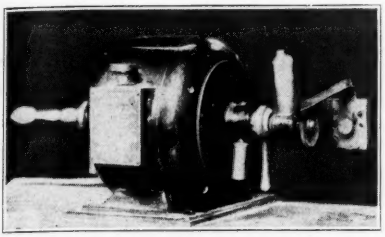


Fig. 6.—Amalgam mixer on lathe.

The alloy is weighed, and an equal amount, by weight, of mercury is added. The amount of mercury, of course, depends on the kind of alloy used.

This amount of amalgam is too bulky to mix with a mortar and pestle, so I have devised an amalgam mixer (Fig. 6). It is a brass cup soldered to a piece of spring steel, 1 inch by 10 inches. The steel strip is fastened to the

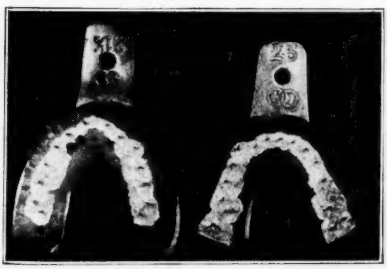


Fig. 7.—Impression packed with amalgam; pins in place.

wall by means of a bracket which permits it to rest on an eccentric wheel attached to the lathe. When the lathe is running, the off-center wheel causes the cup to vibrate very rapidly. This

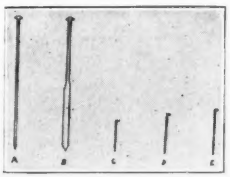


Fig. 8.—Pins used in amalgam models.

mixes the amalgam usually in half a minute.

In Figure 7, we have the impression

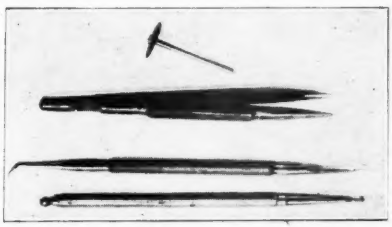


Fig. 9.—Instruments used in placing pins in amalgam models and in packing the latter.

packed with amalgam, and the pins in the teeth. Each tooth has one pin, except the molars, which have two.

Fig. 10.—Cork mats.

The pins are made by flattening the ordinary pin by rolling or hammering (Fig. 8). Flat pins are used so that the teeth will not rotate in the cork

mat. They are used in three lengths: 4/16, 5/16, 6/16. The heads are turned outward on the six anterior teeth and inward on the bicuspids and molars.

Pliers (Fig. 9) are used to insert the

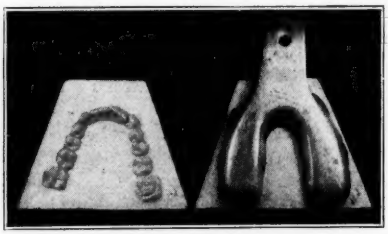


Fig. 11.—Right: Pins pushed into cork mat, impression still in tray; left: tray and modeling compound removed.

pins in the amalgam. The pliers have a groove in one beak which holds the pin straight when it is forced into place. The other two instruments in Figure 9 are used to pack the amalgam into the teeth.

The amalgam should be allowed to set for two or three days. It is then ready to be transferred to the cork mat (Fig. 10, left). This is a ground cork table mat which is cut to size and

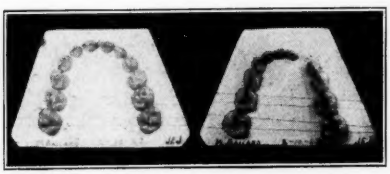


Fig. 12.—Amalgam models trimmed and broken apart, and teeth traced on cork mats.

shape wanted and on which is pasted a piece of drawing paper (Fig. 10, right).

The impression packed with amalgam is now pressed down into the mat. It is important that the impression be kept in the tray to prevent the breaking of the models when forced down (Fig. 11, right). The tray is removed

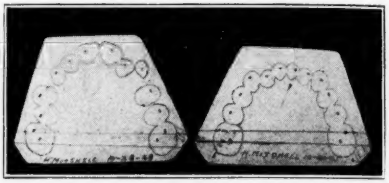


Fig. 13.—Tracings on mat after removal of teeth.

and the compound is chipped off the amalgam model with a knife or other sharp instrument. It comes off easily, and there is no danger of breaking the amalgam teeth (Figure 11, left).

The teeth are now removed from the cork mat and are trimmed around the gingival portion with knife-edge carborundum stone. The teeth are broken apart, care being taken not to destroy the contact point. The lin-

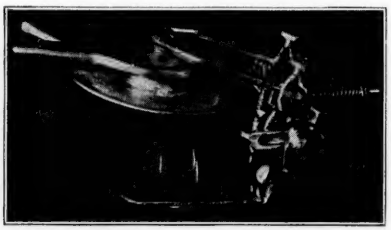


Fig. 14.—Articulator, showing ball and socket joint in upper bow; also, pins on the lower bow which hold cork mats in position in the articulator.

gual and buccal grooves of the molars are deepened with a fine jeweler's saw. The teeth are then replaced on the mat

(Fig. 12), and a hard drawing pencil is used to trace the position of the teeth on the mat. Lines are drawn from the buccal and lingual grooves of the left molar to the buccal and lingual grooves

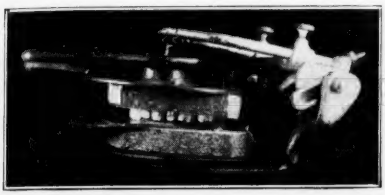


Fig. 15.—Cork mats in the articulator, with wax bite in position.

of the right molar. If these teeth are in normal torsal relation to each other, the lines will be parallel. Figure 13 shows the tracing of the teeth on the mats.

We are now ready to place the models in the articulator (Fig. 14). Any anatomic articulator will do. To the upper bow is attached a plate with a ball and socket joint. This permits the upper plate to fit flat against the

Fig. 16.—Wax bite removed. The models are now ready to be moved into their normal positions.

cork mat. To the lower bow of the articulator, another plate is soldered. Both the upper and lower plates have threaded pins soldered into them. These pins hold the cork mats to the plates.

Figure 15 is a side view of the artic-

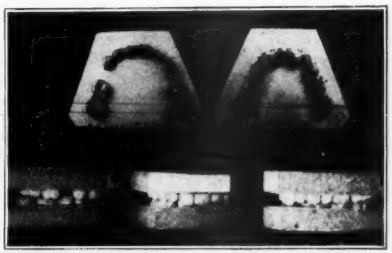


Fig. 17.—Appearance of models, before predetermining.

ulator with models in position before the wax bite has been removed. The bite is necessary to hold the models in normal relation to each other when placed in the articulator.

In Figure 16, the wax bite is removed, and we are now ready to predetermine the tooth movement.

I have no fixed formula in moving the teeth. My plan is to move them

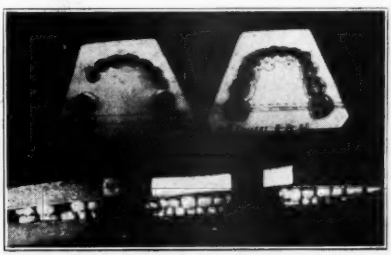


Fig. 18.—Appearance of models (Fig. 17) after predetermining.

into what I think is normal occlusion with the least amount of tooth movement. To do this, I take into consid-

eration the profile of the patient, the class of malocclusion, the etiologic factors, if apparent, the median line, the overbite, etc.

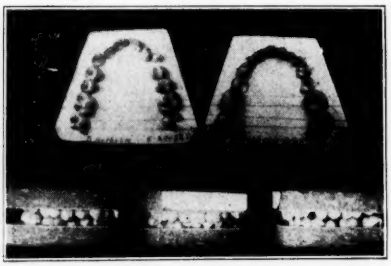


Fig. 19.—A neutroclusion, or Class one, case.

I shall now show several cases of predetermined tooth movement and try to explain why I have moved the teeth into the position shown. I also want to call attention to the fact that it is possible to get amalgam models of any type of malocclusion, and that any change

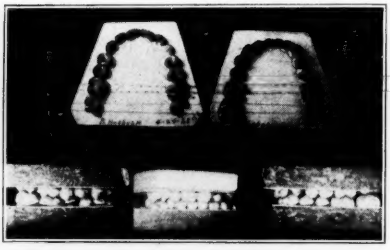


Fig. 20.—Case shown in Figure 19, after correction of the malocclusion by shifting the mandibular arch to the left.

in the three planes in which we are able to move teeth is shown.

Figure 17 shows the occlusal right, left and front views of a case which resembles a distoclusion with linguoversion of the maxillary anterior teeth. The first thing noted is the difference in the size of the two arches and the

Fig. 21.—Case of distoclusion.

excessive overbite; also the drifting forward of the maxillary deciduous molars and first permanent molars, due to the early loss of the right maxillary deciduous first molar and the breaking down of the left maxillary first deciduous molar.

Why is the maxillary arch less crowded than the mandibular? This

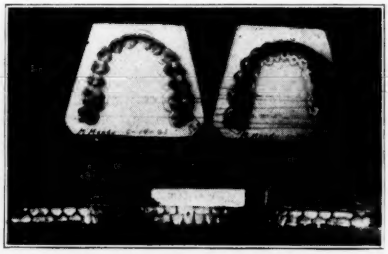


Fig. 22.—Case shown in Figure 21, after treatment.

is due to the excessive overbite; therefore, I open the bite to an average overbite which gives me almost enough room to correct the irregularity in the mandibular arch. Since the maxillary

arch is already crowded, I correct the alinement of the six anterior maxillary teeth.

I then widen the mandibular arch

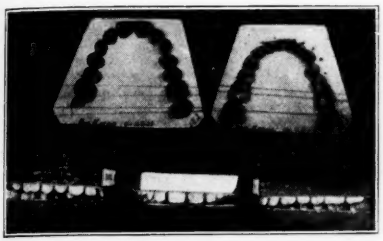


Fig. 23.—Case of distoclusion.

until I have them in normal alinement. When I have done this, I find the mandibular first molars have come forward about one-sixteenth inch, owing to the widening of the cuspid and deciduous molar region. I now move the maxillary second deciduous and first permanent molars back until they occlude in a normal mesiodistal relation with the mandibular molar, and I find this regains the space of the first deciduous molars which have been lost (Fig. 18).

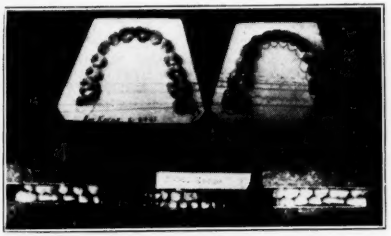


Fig. 24.—Case shown in Figure 23, after treatment.

Figure 19 shows a neutroclusion, or class one, case. The front view shows that either the upper or the lower median line is off. By means of the appliance in Figure 3, I am able to determine that the maxillary median line was correct. So, in correcting the

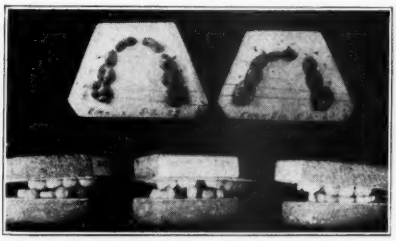


Fig. 25.—A bad case of distoclusion in a child not yet 7.

malocclusion, the mandibular arch was shifted to the left (Fig. 20).

Figures 21, 22, 23, 24 show two cases of distoclusion before and after treatment. In this type of case, I find that I can gain considerable space if I rotate the upper molars outward, and the lowers inward. In each of the cases, the arches were widened, the maxillary anterior teeth retracted and the mandibulars drawn forward. Ow-

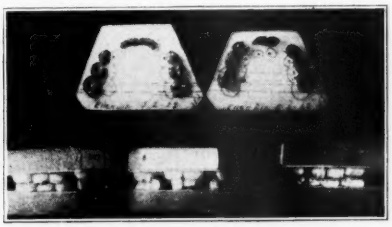


Fig. 26.—Case shown in Figure 25, after treatment.

ing to the excessive overbite, it was found necessary to elevate the mandibular molars and bicuspids. When this

condition is bad, it is necessary to elevate the molars and bicuspids in both jaws in order to retain the curve of Spee.

Figures 25 and 26 show a bad case of distoclusion of a child not quite 7 years of age. I present this case to show the amount of tooth movement necessary to correction. The width of the maxillary and mandibular lateral incisors was judged by Black's table of averages for these teeth.

CONCLUSION

I wish to emphasize the following points in the method I have shown:

1. The time necessary to predetermine a case may be summarized as follows: taking impression, bite and finding median line, 20 minutes; grating down impression, 5 minutes; mixing and packing amalgam, 35 minutes; trimming amalgam models and tracing teeth on mat, 25 minutes; total, 85 minutes.

In other words, one hour and twenty-five minutes of actual working time is required to get the models in the articulator ready to predetermine the case. It will take from fifteen minutes to an hour to move the teeth into normal occlusion, the time depending on the case.

2. The technic is very simple. The average assistant can do all the work except the actual moving of the teeth. It really takes less skill and time to make the amalgam models than it does to make a plaster model from a plaster impression.

3. The cost is trivial, the amalgam being the principal item.

4. The amalgam models can be moved in the three planes in which a tooth can be moved; that is, forward or backward, in or out, up or down, or rotated, and these movements are shown and can be accurately measured.

5. The tooth movement in any denture can be predetermined; that is, the teeth in a deciduous, mixed or adult case can be moved into what we consider to be normal occlusion for that age.

DISCUSSION

C. A. Hawley, Washington, D. C.: Dr. Johnson has shown a method of predetermining work in orthodontia which has a number of advantages over any other method with which I am acquainted. The results are graphic and appeal to the eye as do the plaster models he has been studying. To the orthodontist who has spent years in the study of plaster models of the teeth, these amalgam models carry a clearness and conviction that is not possible with maps. The results of intrusion and extrusion are more clearly demonstrated, as well as rotation, and the effects of these movements on the overbite. A case can be set up on an articulator with advantages that are obtained with no other method. The use of the method does not require expensive instruments, and the work can all be done by a competent assistant in a reasonably short time. I find the method especially useful in cases of mutilation; when a tooth or teeth are congentially missing and when extraction may be indicated. The technic, as described, does not include a method of determining the width of the arches, but that is easily supplied by the use of charts or the Pont measurements. In regard to this technic, I have only one suggestion to add: Dr. Johnson speaks of the cost of the amalgam. I use copper amalgam, which not only is cheap, but also makes a harder and more accurate tooth and can be used many times.

Charles R. Baker, Evanston, Ill.: The paper to which we have just listened is particularly appropriate for an audience of this

kind, composed of general practitioners as well as orthodontists. The ideas presented by Dr. Johnson will prove valuable to any of us who use them in the diagnosis of malocclusion. The details of technic involved are easily understood, and may be readily developed. The outstanding features of this method of predetermining the arch forms and occlusion are: the simplicity of technic as compared with that of other methods which include drawings of the outlines of teeth, and engineering ideas with which most of us are unfamiliar: also the fact that we are able to manipulate the teeth themselves (amalgam models) rather than simply use drawings on paper. When using amalgam teeth, there is no danger of placing the different units in spaces too small to accommodate them, and we will not leave spaces between teeth without knowing it. Errors of this nature might easily occur in the use of drawings. Then, too, we are using the entire crowns of teeth in our calculations, rather than simply outlines of the sizes of teeth at their greatest diameter. The cusps and grooves are all present in accurate reproduction and act as guides in the arrangement of the teeth. Many of us have broken plaster teeth from models and rearranged them, using wax to hold them in place, before a decision was made as to the treatment of a case. We have also cast metal models of some or all of the teeth in a case, and rearranged these as an aid in diagnosis, but the method suggested by the essayist is far superior to either of these, in that it gives us a permanent, accurate model of each tooth and also an accurate record of the original arrangement of the teeth, through the drawn outlines of the amalgam teeth on the cork mat, and the positions of the pins in the mat. The fact that these metal teeth may be mounted on an articulator adds to the value of this method.

I should like to suggest a method of taking the modeling compound impressions in these cases that I believe will prove valuable. It is a method I use in taking impressions of molars for which bands are to be made by the indirect method. Soft compound is placed in the tray, and carried to position in the usual manner. While the compound is still quite soft, the tray is moved to the right and left, also forward and backward, the impression being made much larger than the dental arch. The compound is then removed from the mouth and chilled thoroughly. A thin strip of very soft compound is placed in this hardened compound, and replaced in the mouth, considerable force being employed in pressing it against the teeth. The result will be a very satisfactory impression. The simple device and method for determining the median line is commendable, and it occurred to me that a similar technic might be used to advantage when front view photographs of our patients are being taken, before and after treatment, for considering facial development. We should not depend too much on the transverse parallel lines, as described in the paper, to indicate torsiversion of molars; for it is easy to visualize a case in which all of the deciduous molars were present on one side of the mouth, and all of the bicuspids present on the other side. In this case, we would naturally expect the first molars on one side of the mouth (the side where the bicuspids were present) to be located farther forward than the first molars on the other side. The transverse lines in this instance would not be parallel, but this fact would not necessarily indicate torsiversion of the molars. In predetermining the sizes and forms of dental arches in cases complicated by the too early loss or the prolonged retention of deciduous teeth, particularly molars, careful consideration is required.

FACIAL NEURALGIA OR TIC DOULOUREUX*

By ROY S. HOPKINSON, D.D.S., Milwaukee, Wisconsin

TRIFACIAL neuralgia, trigeminal neuralgia, major tic and tic douloureux are terms that have been applied by various writers to a chronic neuralgia confined to the fifth cranial nerve. Neuralgia is a term that is promiscuously used to designate a recurrent localized pain which usually cannot be accounted for by any special lesion.

When we are dealing with a severe persistent recurrent, stubborn neuralgia of the fifth nerve, from a clinical standpoint it is a major tic, and as such should be treated. As the fifth nerve is responsible for practically all sensations coming from the mouth, teeth, nasopharynx and accessory sinuses, facial neuralgias of this cranial nerve are more common.

A dentist failing to recognize a true major tic often subjects his patient unnecessarily to excruciating pains and recommends the useless extraction of teeth, giving his patient no relief whatever. I wish to make a plea to the general practitioner to familiarize himself with the symptoms of this disease, because it is within his province to see these cases early and prevent years of suffering for these unfortunate individuals.

There are an unlimited number of conditions of a pathologic nature occurring in the mouth around the teeth and investing tissues that demand dental and surgical treatment because of the pain that they produce. The pain frequently is of a referred neuralgic type that will yield when the local cause has been eliminated. An overstimulation of a sensory nerve may produce a pain impulse which is conveyed and recorded in the brain. The recording of this impulse is recognized by the patient by the sending of a return message to the local irritated area. Neuralgia is a very different pain, a severe pain impulse, the evidence of which is referred, and carried to some or all of the terminal branches of the affected nerves, and to the terminal branches of associated nerves.

Neuralgia, then, must be differentiated from ordinary pain, owing to the fact that the return impulses from the brain are radiated beyond the area involved and usually extend to the terminal branches of the nerve trunks.

Trigeminal neuralgia is a highly specialized nerve affliction confined to the fifth cranial nerve and its terminal branches. The pain produced by this type of nerve involvement is of a chronic nature and extends over periods varying from a few weeks to many years.

A convenient classification of neuralgia for this discussion may be made by confining ourselves to two general

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Sixty-Seventh Annual Session of the American Dental Association, Louisville, Ky., Sept. 23, 1925.

classes; i.e., major and minor types. It is safe to say that nearly all neuralgias of the minor type are due to a local cause, which may be determined by careful clinical examination, and this neuralgia usually is amenable to treatment by the elimination of the local factor. In marked contrast, major neuralgia has been a perplexing problem. The literature is full of admissions that, thus far, the origin of this paroxysmal pain is not understood by the medical and dental professions. As in the care of any abnormality of the head and neck, the most important factor to be determined is how to make a careful examination and diagnosis. It is obvious that in no branch of our specialty is the skill of the surgeon taxed to a greater degree in making an examination and diagnosis than in a case of trigeminal neuralgia. By careful recording of the history, ruling out one cause after another by exclusion, the diagnostician finds himself confronted with merely the facts as to the localization of pain, its severity and the duration of attacks, with no tangible cause or origin determined.

While it is true that a careful examination may not reveal the factor producing the trigeminal neuralgia, a search should be made to determine if possible any factor which might be responsible for this agonizing recurrent pain, known as a major tic.

ETIOLOGY AND PATHOLOGY

It is evident, from a review of the literature, that the etiology and pathology of this symptomatic disease is very obscure. The general opinion evolved is that the condition is an ascending neuritis, but the symptoms are unlike those of an ordinary neuritis, and microscopic examinations have not as yet made the clinical picture any clearer. As has been stated, the history of cases of trigeminal neuralgia suggests strongly some origin in the mouth, teeth and investing tissues or accessory sinuses, but a striking characteristic of major tic is the fact that removal of the supposed exciting cause does not relieve the pain complained of by the patient. It is not improbable that the chronic neuralgias of a major type may have been aggravated, if not caused, by local conditions in the mouth, throat, sinuses, nose and eyes. But the secondary manifestation of a neuritis is of such long standing that the exciting cause becomes a secondary consideration, as the surgeon is usually disappointed to find that removal of these probable causes of the neuritis does not give the patient even temporary relief.

In contrast to the major type of neuralgia, the minor type is usually amenable to treatment. It is due to one or more of the following causes: pathologic disturbances of the oral cavity, such as focal infection, pulpitis, pulpstones, pericementitis, excementosis, stomatitis, impacted or unerupted teeth, cysts, odontomas, tumors impinging on nerve trunks, fractures of teeth and jaws and various traumatic injuries to supporting tissues. Last but not least, a marked disturbance in the normal occlusion of the teeth, unilateral or bilateral, known as traumatic occlusion, may also be a factor.

It is also true that under this group may be mentioned pathologic conditions of the nasal cavity and of the sinuses associated with it, which so often produce an acute or chronic sinusitis, abnormalities of these parts, tumors and traumatic injuries of the same.

It may be further stated that those systemic diseases that produce a marked

change in the blood, such as syphilis, malaria, anemia, influenza, toxemia and all forms of disturbances of the nervous system, may have a part in the production of the minor group. Clinical experience has taught that the elimination of either local or systemic factors usually affords a favorable prognosis in minor tic cases.

In a major neuralgia or tic, we do not find predominant factors that produce this neuralgia, and we are confronted with the problem of determining the characteristics in an individual case, the localization of the points from which the pain is emanating and the treatment of the symptoms. The obtaining of a careful history usually brings out certain characteristic symptoms of this stubborn neuritis. Clinical histories reveal the fact that this affliction is almost always unilateral, and is more frequent in the second and third divisions of the fifth nerve than it is in the first. The first or ophthalmic branch of the fifth nerve, I believe, is more often involved by referred pain from the other two branches; namely, the second and third.

These cases of major tic are more frequent in middle life and old age than in the younger periods. The youngest patient I have observed with tic was 35 years of age, and the oldest 82, while in the majority of cases, the ages varied between 50 and 70 years. Most writers have observed that this affliction is more common to women than to men. This neuralgia is never associated with paralysis of the muscles supplied by the motor root of the fifth nerve. At the beginning of this malady, the time elapsing between attacks may be years, months or weeks, and the patient characteristically describes the attacks as becoming more severe and the intervals shorter.

DIAGNOSIS

In both types of neuralgia, namely major and minor, a careful survey should be made of the history, and all local and general pathologic conditions determined as far as possible. A complete blood picture, Wassermann reaction, urinary analysis and physical examination should be obtained in all cases. Every factor should be carefully considered in the examination. All teeth should be looked over on all surfaces for possible local trouble. Examination of the nose, throat and ear should be made and transillumination utilized. A thorough search, with a roentgen ray, should be made for possible local causes. Digital pressure of the parts in the suspected area should be used to locate sensitive nerves. If the ophthalmic division is involved, we have tenderness of the scalp. In passing the fingers lightly over the forehead, pressure over the superorbital notch will give a quick response of pain. When the second division is involved, movement of the upper lip, touching the side of the nose, the lower eyelid and the area immediately over the infraorbital foramen, and a slight touch on the tissue anywhere in the infraorbital region supplied by the second division may bring on a pain. If the third division is involved, touching the lower lip, and pressure over the mental foramen, on the buccal mucosa in the region supplied by the long buccal nerve, on the lingual mucosa supplied by the lingual nerve, on the side of the tongue and over the region of the inferior dental foramen may bring on a sudden attack of excruciating pain.

If the pain complained of is paroxys-

mal, coming on suddenly in a definite area located over some sensory nerve branch, persistently recurring in a few hours, days or months at the same place, and will not yield to medicinal treatment, it is undoubtedly a true tic douloureux. The pains are the same in practically every case. The patient complains of a severe agonizing pain from some circumscribed area which radiates from this area over the particular nerve trunk involved. During an attack, the face shows every evidence of severe pain. Contraction of the facial muscles, moaning and an extreme expression of agony is characteristic. These pains are usually variously described by the patient as severe, agonizing, sharp, shooting, piercing, shocklike and recurrent, varying only in length of duration and the time elapsing between attacks. Patients usually describe the pain as being aggravated by the act of swallowing, masticating, talking, washing the face or blowing the nose or by any other act that tends to bring into action the various muscles of the face and jaws. Many patients give a history of not eating, drinking or talking for days at a time for fear of starting one of the paroxysmal attacks. This leads to marked depression, and extreme cases of melancholia result.

A careful study of all evidence obtained frequently will suggest the treatment of some local or general pathologic condition, which will clear up the symptoms of neuralgia. It is surprising how many patients come under the observation of the oral surgeon who have suffered to a more or less degree with this terrible affliction for from three to forty years. Various guesses have been made as to the cause of pain, and useless operative procedures have been attempted or performed, with the result that the patient has suffered continually for a long period before a correct diagnosis has been made. The tolerance of some of these patients in bearing the agonizing pains over a long period of time is surprising, and the operator feels called on, in most cases of major neuralgia, to cause as little delay as possible in removing pathologic conditions that might be the causative factor in a major neuralgia. Nothing will be gained by extended delays in trying to determine the etiologic factor and the pathologic processes involved in this disease. The evidence of nerve irritation, as I have observed it, is usually peripheral and is confined to terminal branches. It is reasonable to assume that prompt measures should be taken to localize this pain and to block these peripheral sensory nerves in an effort to give the patient relief.

One of the most gratifying procedures in completing a diagnosis of a case of major tic consists in localizing the pain by excluding certain terminal branches by block anesthesia. No one feature of a diagnosis is more important than the determination of the particular nerve trunk or terminal branch that is producing the neuralgia. In addition to determining for the operator the special nerve trunk involved, the injection of a local anesthetic gives the patient immediate relief, insures confidence in the operator and improves the general condition of the patient by giving him a much needed rest. Determination of the cause of the irritation may never be made possible even by a prolonged attempt at diagnosis and does not add to the comfort of the patient nor to his confidence in a favorable result. Peripheral injections give the patient more prompt relief, are attended with less imme-

diate disability and discomfort and are regarded more kindly by the patient.

TREATMENT

All cases of major tic should be referred to a hospital for observation and treatment. It is obvious that it is more practical to treat these cases in the hospital, and the assistance of the internist and pathologist is of inestimable value in determining the diagnosis. In nearly all cases, the imposed rest of the patient produces some improvement in the condition.

In most cases, it is evident, from the history, that internal medication of every variety has been resorted to, together with local applications of counterirritants, and the use of these procedures has given the patient little, if any, relief. In some cases, during the routine examination a combination of phenacetin, 5 grains, acetyl salicylic acid, 5 grains and codein, one-fourth grain, given in capsules every three hours, will give the patient some relief. It has been said that the simpler peripheral operations are safer but less efficient and the deeper operations give more permanent relief. It has been evident, in a clinical observation over a period of eight years, that the injections of peripheral nerves and deeper injections of nerve trunks give relief for as long as do the more radical procedures. The physical condition of many of these patients does not warrant operative procedure, and the employment of block anesthesia in the treatment is attended with less danger and, in the hands of many operators, with very favorable results. The less radical treatment of tic douloureux by the injection of alcohol should always, I believe, be attempted in preference to serious operative procedures. At present, the care of these cases evolves itself into (1) blocking the peripheral or terminal branches of the various divisions of the fifth nerve, (2) blocking the nerve trunks as they emerge from their respective foramen, and (3) blocking the gasserian ganglion.

ALCOHOL INJECTION

Various solutions have been used for injections by different operators, with or without procain, but, at present, the use of alcohol in 90 per cent strength, without the addition of other drugs, is recommended.

Smith, in his book on "Block Anesthesia," has wisely suggested that the injection of alcohol should always be preceded by the injection of a local anesthetic, and that sufficient time should elapse to produce anesthesia before the injection of alcohol. Alcohol, when injected into a sensory nerve, produces a severe burning pain and too much time is consumed in producing anesthesia before the patient gets relief. There is a limit to the tolerance of these patients, and every operator should be aware of the fact that any additional pain will not add to the comfort nor the confidence of the patient. The objection to removing the needle after making injections of a local anesthetic can be overcome, as the needle can be separated from the syringe and left in position, and the alcohol injected after sufficient time has elapsed to obtain anesthesia of the nerve to be injected. The surgeon should convince himself beyond question of a doubt that enough time has elapsed to produce anesthesia before any alcohol is injected. The injection of the local anesthetic gives immediate relief to the patient, eliminates the possibility of pain during the injection of alcohol and establishes

a marked confidence between the patient and operator.

I previously used a combined solution of procain, chloroform, alcohol and water, but I have derived better results from the use of alcohol 95 per cent. The slight dilution of the alcohol by the procain injected does not detract from a favorable result.

The procedure in alcohol injection for tic douloureux should be attended with as much care and attention to the fundamentals governing asepsis as in any form of surgery, in order to insure the least postoperative complications.

Alcohol, when injected into highly specialized tissue, such as nerve tissue, according to most authors produces degeneration of the nerve tissue, which is later replaced by connective tissue. The ability of most operators to obtain success depends on their attention to a definite detailed technic which will place the alcohol in direct contact with the nerve tissue at a point where the excruciating pains will not be recorded in the brain. Premedication of the patient, before the block injection has been made, is of marked advantage. If the injection is extra-oral, the skin should be as thoroughly prepared as it would be for any surgical procedure.

REPORT OF CASES

CASE 1: Mr. W., an insurance agent, aged 59, married for thirty-five years, with no children, presented a case in which the provisional diagnosis was paralysis of the facial nerve on the right side, with neuritis of the fifth nerve on the same side. He complained of pain in the right side of the face, apparently emanating from the third division of the fifth nerve. In fixing a battery on his car, he got some acid on his finger, and, in touching his face and tongue, received a severe burn. In shaving, the condition became much worse and the attacks were closer together. Formerly, the attacks came twice each night. At present, there were three or four each night, and two or three each day. The patient could cause pain by touching the right ear. The attacks were associated with marked muscular spasms, and the patient rolled about in bed and moaned loudly with pain. Examination of the mouth showed that the teeth had been removed ten years previously. There was no history of headaches, sore throat, coughs, shortness of breath or cardiac palpitation. The genito-urinary examination was negative. The patient had had most of the diseases of childhood, influenza when an adult and a fracture of the right leg, thirty years previously. His father died of acute nephritis, his mother, of cancer of the breast. A sister died from an unknown cause. The patient's habits were normal and his appetite was good. He had slept well until the onset of the present condition. He smoked heavily. He had used alcohol formerly, but took very little at present. Physical examination showed that he was well nourished and well developed. He was very restless. The skin was soft, moist and of good color. There was no evidence of any eruption. Examination of the head and scalp was negative. The patient was unable to close the right eye, and the right pupil was much larger than the left. Both pupils reacted readily to light and in accommodation. There was complete paralysis of all the muscles on the right side of the face. Examination of the nose, ears, mouth, neck, chest, abdomen and extremities was negative. The blood pressure was: systolic, 222; diastolic, 158. The roentgen-ray examination was negative. The urine gave a plus 2 reaction to the sugar test. The Wassermann and other blood tests were negative. A diagnosis of diabetes was made, and the patient was placed on diabetic diet. He was dismissed from the hospital on the eighth day, with the paralysis improved and neuralgia of the third division of the fifth nerve entirely overcome.

CASE 2: Mrs. C., an American housewife, aged 57, presented a case in which a provisional diagnosis of trigeminal neuralgia involving the second division of the fifth nerve, manifested on the right side of the face and terminal branches emerging from the intra-orbital foramen, was made. The patient had mitral regurgitation and aortic stenosis. The present trouble developed at the age of 18, with a burning sensation of the right side of the tongue. The pain grew

worse and, for weeks, the patient could not eat or talk, having to write her communications on a tablet. When the condition first developed, she would be free from pain for several months during the year. Twelve years previously, she had had a deep alcohol injection, with no relief. All the upper teeth were removed, but no relief was experienced. The patient had had the usual childhood diseases. Sixteen years previously, she had pneumonia, followed by the development of a heart lesion. Twelve years previously, a tumor of the breast had been removed. The patient's father died at the age of 78, from heart trouble, the mother, at 62, of cancer of the stomach. There were two sisters and one brother living. One daughter died of typhoid and one of prematurity, and there was one miscarriage. The roentgen-ray examination was negative, as were examinations of the urine and blood. Injection of the second and third divisions of the fifth nerve was carried out, with 95 per cent alcohol. The patient developed marked edema of the right side of the face, but the pain subsided.

CASE 3: Mrs. J., an American housewife, aged 52, presented a case in which a provisional diagnosis of trigeminal neuralgia involving the third division of the fifth nerve was made. She complained of pain over the region of the left lower jaw, of fifteen years' duration. She had been operated on for tic douloureux three times in the last three years, with no relief. Her general condition was good, and she had never before had any illness of a serious nature. Blocking of the long buccal nerve, with procain, relieved the pain completely. An alcohol injection was used, and the patient was discharged free from pain.

This case illustrates one of the points made above as to the importance of a careful diagnosis. The fact that the operative procedures on the inferior dental and lingual nerves did not relieve the pain and that blocking the long buccal nerve did relieve the pain discloses the fact that the surgeon was not careful in his diagnosis.

CASE 4: Mrs. R., aged 69, French, a housewife, gave the following history: Her father died of old age, at 91; her mother, at 50, of apoplexy. The patient had eight children, two of whom had died. She stated that her health had always been good. The present complaint was of eight years' duration, and followed an attack of grip. She complained of intermittent pains, which were extremely severe on the left side of the face and nose. The pains occurred every four minutes and lasted from twenty to thirty seconds. The lacrimal gland and the eye on the painful side were highly inflamed and the lacrimal gland was infected. The urine and blood examinations were negative, as was also the roentgen-ray examination. The terminal branches of the second division of the fifth nerve were injected at the infraorbital foramen with 95 per cent alcohol. No marked edema followed, the eye improved, the pain ceased and the patient being dismissed.

CONCLUSION

I have had two cases in which pain returned in four months after an alcohol injection had been made. In some cases, a second injection has been made after several months, with no return of pain. Some of these patients have been completely relieved up to the present date, injection having been made as long as eight years ago. I have derived a great deal of satisfaction from being able to give these patients some relief, and I believe that the conservative treatment, namely, of alcohol injections, should always be tried before surgical procedure is attempted. I do not claim the distinction of presenting anything new, but merely wish to emphasize the practical application of a comparatively simple method of relieving the many unfortunate persons afflicted with trigeminal neuralgia.

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DISCUSSION

Arthur E. Smith, Los Angeles, Calif.: The presentation of this paper is of immeasurable value to the practitioner because it impresses on him the importance of carefully employing the various diagnostic and curative methods that are well known to the specialist. Not only is it important to determine the

pathologic conditions but also to employ the proper medicinal and surgical treatment before subjecting the patient to a more radical operation. Patients suffering from conditions involving the fifth cranial nerve and the tissues supplied by this complex division of the central nervous system seek relief primarily by consulting either the physician or the dentist. Is it not a fact that, in tic douloureux, the etiology is so often obscure that both medical and dental skill are required to locate the pathologic condition and to render the proper medical and surgical treatment? No ailment to which an individual is subjected can compare in severity of pain with tic douloureux. Dr. Hopkinson has emphasized the fact that a dentist who fails to recognize this condition often subjects his patient unnecessarily to excruciating pain and recommends extraction of teeth which may give no relief whatsoever. In this I agree, but why place all the burden on the dentist? Why not add that, in many cases, the physician has been in error and has recommended the removal of healthy teeth? Such cases have come under my observation. Cases of tic douloureux having an obscure etiology require the collaboration of physician and dentist. The fifth cranial nerve is one of the most extensively distributed and most sensitive nerves of the body, supplying sensation to the face, conjunctiva, nose, frontal and maxillary sinuses, teeth, palate, tongue, upper part of the pharynx, scalp of vertex, external auditory meatus, three quarters of the dura mater, falx and tentorium. Not only are these parts supplied with sensation by this nerve, but, in addition, it supplies the parts with trophic, vasomotor, and secretory fibers. The vasomotor and secretory fibers connect with the medulla and cervical spinal cord via the sympathetic. The sensory part of the fifth nerve is subject to sensory neuroses, such as neuritis, paresthesia and anesthesia, and its etiologic diagnostic relation and treatment of terminal reflex neuralgia is a complex problem which concerns the oral surgeon and the eye, ear, nose and throat specialist. Dr. Hopkinson has covered the most common etiologic factors. I wish to emphasize some points which deal with the pathology. The trigeminus is subject to two types of neuralgia, that is, symptomatic pains and spasmodic pains or tic douloureux. Tic douloureux is a special form of trifacial neuralgia appearing as a rule after middle life, usually displaying severe symptoms, obstinate in its course and, in many cases, dependent on changes in the nerve itself. The peripheral or extracranial reflex and the retroganglionic types may be caused by some form of intracranial or cortical lesion, such as tumor or gumma. The various forms of psychoneuroses that so often attack the fifth nerve are purely symptomatic and are only secondary manifestations of other pathologic conditions. These conditions will, in most cases, yield to treatment other than that which is necessary to arrest or remove the cause of the primary pathologic condition of the nerve trunk, which is recognized as tic douloureux. Tic douloureux is no doubt due to either a toxic or a trophic process which exists in the nerve itself, gasserian ganglion or brain. Sluder has described a pain syndrome which is present with a pathologic process affecting Meckel's ganglion, and he states that undoubtedly the pathologic condition is due to irritation and that this form of neuralgia is common. Therefore, the possible involvement of Meckel's ganglion should not be overlooked in making a diagnosis. A low grade neuritis caused by an alveolar abscess, infected tonsils, deflected septum, empyema of the antrum or impacted teeth as a rule does not show changes in the nerve branch, but the arterioles that supply the nerves undergo an endarteritis which causes their caliber to decrease; which prevents the nerve from receiving its proper nutrition. In some cases, the gasserian ganglion has shown degenerative changes which are considered purely secondary, because the removal of the nerve trunk eliminates the pain. In some cases, neurotic changes have been found, such as an increase in connective tissue or an increased vascularity, but the cause of this pathologic change has not been determined. It is thought by some to be the result of former treatment, such as the injection of alcohol or operative procedures. A definite bony protuberance situated on the superior anterior surface of the apex of the petrous portion of the temporal bone and extending into the nerve tissue has also been observed. Without doubt, this extension of bone is an exostosis and a possible causative factor in the production of tic douloureux. Important etiologic factors that must not be overlooked in diagnosis are the impingement on the nerve by a tumor, exostosis, cicatrical tissue, syphilitic gumma, extreme exposure, infection, depressing influences, pathologic conditions existing in the orbit, empyema of the antrum

and frontal sinus involvement. There is no question that alveolar abscesses, decayed teeth, pulp stones, abnormal roots, impacted or unerupted teeth, necrosed bone, trauma, herpes zoster and chronic tonsillitis have played an important rôle in producing the symptomatic type of trifacial neuralgia, which predisposes to major tic douloureux. Dr. Hopkinson has discussed this subject from a clinical standpoint as major and minor tic douloureux, which is a very satisfactory classification. The classification which I follow with more or less success, and which I believe will materially aid the diagnostician, divides the cases into the symptomatic and tic douloureux groups. These two main groups are further divided into (1) those cases in which the pathologic process is purely peripheral, preganglionic or extracranial; (2) the ganglionic type; (3) the retroganglionic type or intracranial reflex type caused by new growths, tumors, cortical lesions, etc., and (4) symptomatic pains caused from other lesions which yield to a different treatment than that for a primary type of tic douloureux. Dr. Hopkinson has particularly stressed the importance of making a thorough diagnosis, utilizing all modern methods such as the roentgen-ray and physical and laboratory examinations; all of which are not only essential but also imperative. From time immemorial, a vast therapeutic arsenal has been employed for the relief of this distressing affection. Some of the drugs employed internally are: nitroglycerin, aconite, codein, gelsemium, arsenic, phosphorus, iron, quinin, strychnin, camphor, and various other drugs in the form of liniment. Modern medicine has not discovered a specific drug for the cure of this disease. Ingenious methods of neurectasia and neurectomy have been devised, some of which are of value for the relief and possible cure of the peripheral forms. The most efficient treatment at the present time for tic douloureux is the removal of the cause, if possible. If the etiology cannot be determined, then the employment of (1) blocking the nerve branch at its exit from the skull with alcohol; (2) blocking Meckel's ganglion; (3) blocking the gasserian ganglion with alcohol; (4) neurectasia and neurectomy, and (5) intracranial division or avulsion of the sensory root of the fifth nerve, is recommended. In treating these patients, I have employed numerous drugs, and the best results in cases presenting obscure etiology have been obtained by blocking either the nerve trunk or the gasserian ganglion with alcohol or removing or severing the nerve. The patient should always be treated by deep alcoholic injections before radical surgical methods are employed. Years ago, I advocated the blocking of the suspected nerve trunk with procain, as the resulting anesthesia materially aids in locating the affected nerve branch, provided it is of the peripheral or preganglionic type. By the process of exclusion, it may be possible to locate the branch affected. Such a procedure may take several days. When the affected branch is located, alcohol is injected after the nerve has been previously and completely blocked with procain. If the pathologic process is ganglionic or intracranial, the gasserian ganglion is blocked. Only after medicinal treatment and blocking have failed should operative surgery be employed. The kind of surgical treatment given after alcoholization has failed depends on the nature and location of the pathologic process.

Theodor Blum, New York City: Before undertaking the study of this subject, we should know exactly what the classification of the particular disease is. The classification which has been here presented is, in my opinion, a little bit too large for the average practitioner. The simplest classification divides those cases in which there is pain in the face into trifacial neuralgia and facial pain. Trifacial neuralgia would include the first group mentioned by Dr. Hopkinson; namely, the major neuralgias. One of the symptoms may be tic; the other one, facial pain, may be caused by almost anything about the face and jaws or any part of the body, and in this group of cases we may, and do quite frequently, find the cause; while in cases of trifacial neuralgia, without or with tic, a cause has never been found so far. This is according to our greatest authority on the subject, Frazier of Philadelphia, so that if you do find a cause for what you have diagnosed trifacial neuralgia, your diagnosis is probably wrong. It was a tumor of the brain, perhaps, with pain in the face, as one symptom, but, aside from this, there are other symptoms which are usually found in brain tumors. All possible causes of facial pain or trifacial neuralgia must be removed, even if the diagnosis of trifacial neuralgia has been made. I think that all surgeons must examine their patients completely by roentgen-ray and otherwise and remove every

possible cause, even all devitalized teeth, to be sure that every possible cause has been removed. A consultation with a neurologist is absolutely essential, and other specialists, such as the ophthalmologist, should be consulted when it is necessary.

I disagree with the discusser who was in favor of injection first, followed by operation, if the injection had not been successful. Injection, to my mind, is only useful in the diagnosis of these cases, and, here again, I cite Frazier as the greatest authority whom we have. He believes that the operation should be performed as soon as the diagnosis has been established; and this is very important, because all the deep injections make the operation so much more difficult. If you will read Frazier's papers and his statistics, you will be well informed as to the fact that the intracranial operations are accompanied by an extremely small mortality rate, and that those operations have been performed even on old persons, with success.

Samuel Rabkin, Cincinnati, Ohio: I fully agree with Dr. Blum that a careful diagnosis must be made before one determines that facial neuralgia is present as a result of reflex pain in contrast to tic douloureux. When one sees a typical case of tic douloureux, it cannot be confused with any other type of neuralgia. A flush is noted on the side of the face where the pain is located, and the patient will hold his face, applying some pressure, which is the only procedure that gives him relief. He usually cannot speak clearly but stammers on account of pain. There are many disorders which simulate trifacial neuralgia or tic. I was once asked to give an alcohol injection in a case in which a diagnosis of trifacial neuralgia or tic had been made, only to find that the pain was due to reflex origin from an imbedded root underneath a plate. Two other cases have come to my attention within recent months, both with symptoms of severe neuralgia. One patient had worn artificial teeth for several years, and it was discovered that an impacted cuspid in the center of the palate acted as the irritant. On investigation, there was no sign or symptoms associated with tic douloureux. The other patient had mastoiditis with most of the pain radiating from behind the ear. It is possible that reflex pain may produce symptoms of tic. Careful questioning and examination will often demonstrate the source of irritation. It is often difficult to obtain the physician's consent to the alcohol injection, fear of keratitis or other eye complications that might follow the injection being the reason given. In the number of patients I have treated, I have never seen the need of making an extra-oral injection. The intra-oral injections of alcohol will do all one desires. The oldest successful case that I have on record is of an injection which was made four years ago, with no recurrence. I am not in favor of operation unless the alcohol injection fails. I understand that Frazier can do a ganglion operation within half an hour. I have seen an eminent surgeon perform such an operation in about two and one half hours. Since in most hands the operation is rather prolonged and difficult, I feel that it is not the method of choice except when the alcohol injections are not successful. I have never seen opiates relieve the pain. Relief can be obtained only by the alcohol injection.

Dr. Hopkinson (closing): Dr. Blum has mentioned Dr. Frazier, whom we all know as being of unquestionable reputation as far as surgery is concerned. I do not believe that there are many Fraziers in the country. I do not believe there are very many dentists and surgeons in this room who honestly and frankly would subject themselves to intracranial operations for tic douloureux before they would have an alcohol injection made. I am frank to admit that I do not get 100 per cent results. Dr. Blum has mentioned the patient having keratitis, an infection of the lacrimal gland; it has been my experience that nearly all the cases of trigeminal neuralgia have an involvement known as keratitis, the second division being the branch involved. Invariably these cases show a lacrimal gland infection before any injection has been made, and I presume it is caused by the patient rubbing the eye with unclean fingers or an unclean handkerchief in his effort to relieve the pain. Invariably the patients have keratitis, and they may not have had any injections whatever, so it doesn't necessarily follow that the injection is responsible. I want to emphasize again, in regard to these unfortunate individuals who come into your hands, that an early interpretation of these neuralgic pains will sometimes prevent a chronic neuritis or tic douloureux.

DIET FOR DENTURE PATIENTS*

By VICTOR H. SEARS, D.D.S., New York City

THE dentist who equips a patient with dentures constructed according to the most approved methods, balances them, adjusts them and applies all of the scientific principles of denture construction according to the best of his ability has not discharged his full responsibility until he has instructed the patient as to how to use the new artificial substitutes.

In the past, it has not been sufficiently appreciated by the patient, physician or dentist that a whole new set of problems besets the patient when he loses his teeth and supplants them with substitutes. No race nor individual ever radically changes the diet without physiologic detriment, and yet, unless the matter is given intelligent consideration, the average denture patient is forced both radically and suddenly to change his diet on losing his natural teeth.

In this light and in view of the fundamental importance of proper nutrition, the intelligent patient should be made to see that he is at a serious crisis in life. With this thought in mind, he becomes receptive and may be guided by his dentist. How many of us under these circumstances are capable of safely guiding our patients through the crisis, and afterward?

The presence of artificial dentures is nearly always evidence that the patient has been improperly nourished. The loss of teeth, as we now know, is practically never a purely local matter. It is caused principally by a general condition of malnutrition. This means that while the natural teeth were present, the patient ate improperly. With the loss of his teeth, the probabilities are that his eating habits will be even less adapted to his body needs. Civilized man is not fully adapted to our rapidly changing food supply, nor can he tolerate food in the forms best suited to his primordial ancestors. If this is true of the average adult with his natural teeth, it is even more of a consideration in the case of the denture patient. Man cannot suddenly change his diet without paying the bill.

Our problem is largely one of providing the food elements of our ancestors (those food elements which have been biologically tested throughout past ages), but providing them in the forms best suited to the individual in his present physical condition. We must help the patient over the critical period when he loses his natural teeth.

Every dentist should be a dietitian. This does not mean that he should keep a room full of guinea-pigs, rats and monkeys for the purpose of making physiologic tests of various diets. He should, however, know something of

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the findings of those who are doing such things. He does not need to equip a chemical laboratory to analyze food substances, but he should read the results available in contemporary literature. In other words, we can easily acquire knowledge which has cost others dearly. This we should do for the benefit of our patients as well as for the benefit of ourselves and families.

Now the problems of the edentulous patient are not so different from those of other human beings in matters of food content, but they are different in matters of treatment. With the idea in mind that the patient should not suddenly change the eating habits of a lifetime, let us briefly consider the problems of the human being with impaired masticating ability.

PURPOSE OF EATING

First, let us understand the purpose of eating, whether as regards an edentulous human or as regards a guinea-pig.

There are fewer than 100 known elements, about one-fifth of which are necessary to our physiologic existence. Some elements are needed in large quantities, some in small quantities and some not at all. For instance, we require much oxygen, little fluorin and no helium; we need much calcium, little iodin and no lead. The elements which we do not require are usually poisonous to the body, and even those elements which are necessary must be in suitable compounds. Chlorin and phosphorus are essential to our existence, and yet, if taken in the pure state, they are violent poisons. It is clear, therefore, that our food requirements are exacting—a fact that most people apparently have never suspected.

There are nearly twenty elements that go to make up the body, and these elements are constantly being thrown off by the body in its normal catabolic operation. Unless the calcium, phosphorus, magnesium and all of the other necessary elements that leave the body are replaced by more calcium, phosphorus, magnesium, etc., there will be a deficiency in the body. This deficiency must be made up in the form of food or the system will inevitably suffer in some respect. We may say, then, that the principal purpose of eating is to replenish the body tissues.

If, after growth, the chief purpose of eating is to replenish the tissues, we must eat foods containing those elements that the tissues lose in metabolic activity. These substances cannot be combined in a test tube, but must be compounded by the vegetable kingdom to meet the requirements of the body. Calcium, for instance, may be taken in its inorganic form, but the body is not constituted to make the best use of it when administered in this fashion. The same calcium may, on the other hand, be spread on a field of growing lettuce; and the lettuce will take up the mineral calcium and compound it into a preparation ideal for animal consumption. The compound will be decomposed in the body and returned to the ground again, ready for vegetable life to start it on another course. Thus, we have a cycle of mineral, vegetable, animal and again back to mineral. It is obvious that if the mineral content of the soil is deficient, the vegetation grown on the soil is also mineral-deficient, and the animal diet will be deficient because of the soil deficiency.

Pineapple is said to contain 0.3 per cent iodin, but pineapple grown on soil devoid of this element will contain none. The eating of pineapple will

supply the body with iodin only when iodin is present in the fruit.

Soil content is a large and growing subject that cannot be more than mentioned here. We must assume, for the purpose of our discussion, that the vegetables we are using were grown on soil adequate in mineral content. Even when we consume flesh, we are concerned as to whether the animal was fed on a diet containing the necessary mineral elements in assimilable form, because flesh deficient in its mineral content cannot satisfactorily supply the mineral requirements. The same is, to an extent, true of the fat, protein and carbohydrate content, and also of the vitamins. Cow's milk depends for its food value on the food that was eaten by the cow.

COMPARATIVE FOOD VALUES

Thus, it will be seen that the so-called natural foods vary greatly in their comparative value. If it is true that some of the fresh meats and vegetables are low in their food value, it is even more evident that the same foods become less suitable when subjected to some of the methods of preservation and refining developed within the last few years. Take, for example, sugar. The juice of the sugar cane contains certain amounts of iron, calcium and other minerals, in a balance determined by Nature. Now when this same juice of the sugar cane is subjected to the demineralizing and refining process by which all of the valuable minerals are extracted, the resultant white sugar of commerce is not only a deficient food in that the balance of elements has been disturbed, but it is also more irritating to the digestive tract if consumed in large quantities.

The rice of commerce has the outer husk removed, making it a deficient food. Corn meal is usually degerminative, and so all down the list of our food substances found in the grocery stores. Aside from the fresh and canned vegetables, most of them are so treated, or mistreated, that they keep well, but they do not supply the body with the required compounds. It seems that there is a certain desirable balance of elements present in practically all of the foods as prepared by Nature. It is this group of balanced combinations that animal life has been accustomed to for millions of years, and it should, therefore, not be surprising that animal life today thrives on it and that any great disturbance in the accustomed combinations will be reflected in impaired health.

Take the example of wheat. Grown in suitable soil, it contains a certain combination of elements that is readily taken through the blood stream and easily used to replenish the tissues of the body. Now the high patent flour so popular today has been robbed of most of the elements needed for replenishment; balance has been destroyed, and because the required elements are not in the flour, the tissues are not replenished and are, therefore, not healthy, unless the deficiency is made up with other foods. White flour, therefore, is a starvation food.

Feed a man on white flour alone and he will soon die. Add another food that has been robbed of the same vital elements, white sugar for example, and he will die in about the same time. A large number of deficient foods of the same class might be freely partaken of and still not save the individual from death. He would starve, apparently in the midst of plenty.

It might be argued that we supply

the deficiency in other foods, and this is true to a certain extent; but when a large part of the food intake consists of deficient foods, the deficiencies are rarely fully made up, and sometimes, practically speaking, not supplied at all.

America, the land of keep-forever breakfast foods, consumes tons of denatured and demineralized materials every morning at the breakfast table. Just as a dash of milk on a starvation breakfast for a time assures a certain amount of nourishment by making up to some extent the deficiency, so the fact that we are large consumers of dairy products has saved our nation from much greater physical decline than that now evident.

Proper nourishment is necessary to normal muscular strength, mental alertness, glandular activity, resistance to disease, repair after injury and a general feeling of well-being. All of these together we call health, and health is Nature's intention toward every living being.

Perfect health among human beings is the exception instead of the rule and it is becoming more and more exceptional as our foods are more and more robbed of the vital elements. Some of the starvation foods are put up in such tempting packages and are so easily chewed that our denture patients, many of them, fall naturally into the habit of eating them unless intelligently warned.

The changing form of our food supply, however, is not an unmixed evil. It may be turned to advantage when fully understood.

In matter of content, the food problem is the same for the dentulous as for the edentulous. At this point, we must take into consideration the fact that the edentulous patient should not be expected to take average foods prepared in the average way and satisfactorily chew them. The food content should be the same as that for the individual with good natural teeth, but the preparation should be adapted to the needs of a less efficient chewing mechanism.

FOOD COMPOUNDS

Dietitians generally agree pretty well at the present time as to the necessity of six food compounds: proteins, carbohydrates, fats, vitamins, salts and water. We shall not go into the subject of water further than to say that large amounts of liquids, at other than meal times, should be taken. Aside from this consideration of water, some knowledge is necessary of the other five food principles on the part of the patient. The dentist should be familiar with the standard literature on the subject.

Proteins are supplied, as you know, primarily by animal foods and the legumes. Denture patients do not need, and elderly people particularly should not partake of, large amounts of protein matter.

The carbohydrates are supplied principally in the form of potatoes, rice, wheat and other cereals. In the case of the average patient, there is no particular danger of eating too large a portion of carbohydrates, provided the carbohydrates are properly prepared before reaching the stomach. This we shall consider a little later on.

Fats should be supplied principally in the form of egg yolk, butter and the vegetable fats of low melting points. The animal fats are not so readily assimilated. The fat requirement is comparatively small.

The vitamin requirement of the body is not great, but the vitamins are essential to health and growth. The fat soluble A vitamin is present in large

quantities in butter, cream and egg yolk. Water soluble B and C are found in considerable quantities in milk, all of the green leafy vegetables, tomatoes and citrous fruits, all of which should find a large place in the dietary of everyone. Tomato juice, orange juice and milk are highly recommended to denture patients, and are easily available because they require no special preparation to make them suitable for the dinner table.

The mineral salts are present in large quantities in most fruits and vegetables, and when large quantities of the juices of fruits and vegetables are included in the diet, there is no particular problem on the part of denture patients.

While it is not practical here to go minutely into the matter of the denture patient's food elements, we are safe in telling him that he should get plenty of fresh green, leafy vegetables as well as the cooked vegetables, some meat stock and plenty of uncooked fruit juices and milk. The patient may not tolerate much cellulose in the form of cabbage, bran, celery, etc., but this is not because he does or does not wear artificial dentures. He should be given to understand that there is no reason why his body cannot be just as well nourished with his impaired masticatory equipment as it ever was previously, provided he gives attention to the intelligent selection and preparation of his food materials.

In the selection of materials which are to find their way to the dinner table, we should bear in mind that we are buying elements to replenish the bones, muscles, skin, glands and all other parts of the body. We are not in a position to decide whether an article is expensive or inexpensive without a consideration of this phase. Many a family would be better off physically as well as financially if foods were selected with this idea in mind.

PREPARATION OF FOODS

For denture patients, those things which cannot be either served in small enough pieces to be swallowed as prepared or cannot be prepared in soft enough form to be chewed without much effort should be avoided. When one uses a food grinder and a cook stove, there are few things that cannot be made suitable. Many of the leafy vegetables, such as cabbage and lettuce, can be cut so fine that no further cutting will be required in the mouth. The group of foods usually cooked, such as potatoes, peas, cauliflower, etc., are sufficiently softened in the cooking process to make cutting with the teeth unnecessary.

In cooking, there are two principles to be kept in mind: 1. Prolonged heating, especially in the presence of air, as is usually done, robs food of some of its virtue, particularly through loss of vitamin content, for which reason the heating process should not be prolonged unnecessarily. 2. All of the food elements should be saved. Primarily, this means that the habit of cooking food in an excess of water and then throwing away the water, or the liquor, is a wasteful and flavor-losing habit.

It should be borne in mind that no food of any kind ever reaches the needy tissues of the body in solid form. Everything must be put in solution before it can pass through the intestinal wall. Now the boiling process dissolves the most readily soluble parts of the food, and these easily soluble parts, the ones that the body most easily takes up, are the very ones that are so frequently thrown down the kitchen sink, leaving

the less soluble and therefore oftentimes less suitable portions to be eaten. Then, too, often the most soluble parts thrown away in the sink are the parts that the body needs in greatest abundance. It is not simply a matter of throwing dollars down the drainpipe, but principally a matter of depriving the body of some very necessary things.

Unfortunately, such things as potato water, cauliflower water and carrot water are not palatable to many people; which is another reason for throwing them away; but all of these liquors in which vegetables have been boiled and which contain the elements needed by the body may be used in making soups. The denture patient should rely in large measure on soups for his nourishment. Nothing could be more sensible than to save the cooking water to be used in the making of soups of various kinds.

Another way of saving the easily soluble elements is to steam or bake the foods. The only vegetables which require exceptional treatment are the green, leafy vegetables, such as cabbage, celery, lettuce and water cress and these should be made into salads by first running them through a food grinder, thus cutting them into small pieces so that they may be swallowed without much mastication. Some patients object to the treatment at first, on the ground that the vegetables do not taste as they used to, but obviously this is largely a matter of imagination, and the patient should be given to understand distinctly that the pleasure he previously enjoyed in crunching the crisp celery and lettuce is probably denied him for the balance of his life.

The preparation of food for the system does not end when the food reaches the dinner table. The mouth preparation is of extreme importance. It may be thought that the cutting and chopping of food has solved the problem; but this is not the case. Even though the food materials have been cut sufficiently fine or softened sufficiently to be swallowed easily, this should not in any way relieve the patient of his responsibility in chewing his food. This applies particularly to the carbohydrates.

MASTICATION AND DIGESTION

Digestion is carried on to a large extent in the mouth by the action of saliva on the food material, and particularly is it necessary thoroughly to insalivate all carbohydrate foods because these are not digested by the stomach. The mixing of the finely cut or softened particles with saliva is absolutely essential and should be given even more attention by the denture patient than by the normal person.

In the case of persons with good teeth of their own, the most natural thing to do, especially with foods that must be further cut and ground before being comfortably swallowed, is to chew; and in the process of chewing (incidentally as far as the individual is concerned), the food material is mixed with saliva. With the denture patient for whom the food has already been finely cut or softened, there is not the necessity of chewing for comfortable swallowing. In view of this fact, the denture patient must be given to understand that even though the food is prepared so that it may be easily swallowed, it should not be swallowed without first being chewed or mixed in the mouth until the food particles have been brought into contact with the secretions of the mouth. It is just as important that food materials be thoroughly chewed or mixed when they have been previously ground or softened as when

they are put in the mouth in a hard or tough state. The only difference is that the individual is much more prone to swallow the food material without mixing with the secretions of the mouth when this material is finely cut or softened before being taken.

There is a strong tendency on the part of most persons to swallow the bolus of food as soon as this can be comfortably accomplished. It is difficult even for the intelligent and willing patient to overcome this tendency. In the preparation of foods, it is possible for the patient, in large measure, to overcome this tendency by preparing the servings in a dry or nearly dry condition and refraining from drinking until the mouth is emptied of food. This will necessitate insalivation.

It should be borne in mind that the secretions of most of the glands in the body decrease with age and also that they decrease after continued stimulation. Applied to the secretions of the mouth, this means that elderly people should chew their food longer than younger ones should, and, applied to all of us, it means that the most copious flow is at the beginning of the period of stimulation, or, practically, at the beginning of the meal. For this reason, it is obvious that those foods that require the greatest amount of mouth secretions to be most efficiently handled by the body should not only be chewed longer, but also should be taken at the beginning of the meal.

Another important phase of preparation in the mouth for digestion of foods is tasting. All foods should be chewed until thoroughly tasted. This not only adds to the pleasure of eating (and eating should always be a pleasure), but it also has a desirable preparatory effect on other parts of the digestive tract. Food that is bolted or washed down is never so well taken care of, because the digestive system is thus taken by surprise. When the food is tasted and enjoyed, the other parts of the digestive system are prepared in advance for the reception of the food material. This is Nature's intention, and, as in the case of everything natural, a far better result is obtained than when the food is merely washed down the esophagus into the stomach. We must impress on the minds of our patients the great necessity for deliberately tasting every morsel of food eaten.

The judicious stimulation of salivary secretions should not be underestimated, and while it is true that condiments are in the main injurious to the digestive system, they should not be regarded as an unmixed evil. If condiments are necessary in order to excite the flow of mouth secretions and in order to get enjoyment out of eating, their use to the extent necessary to secure these desired effects is justified. It is better to relish one's food even though the food itself is not perfect than it is to eat foods that we consider more nearly ideal but which are not enjoyed.

Little need be told the denture patient about digestion of food. The less one thinks about digestion, the more likely the digestion is to be satisfactory. The only thing to be considered in this connection is that no such feelings as fear or anxiety should be allowed to impair the natural process of digestion. This simply means that a person stricken with grief or anger, or any other of the unpleasant emotions, cannot get the full value out of food, and in fact any kind of food may be detrimental if eaten during the height of unpleasant emotions. Therefore, the denture patient,

as well as anyone else, should know that tranquility is a great aid to easy digestion. He is also in need of rest after eating.

CONCLUSION

It will be seen that the problem of the denture patient is both definite and serious. Grave consequences often follow the struggle of a patient with his dentures in an effort to chew as normal people do; and yet the solution is simple. It lies within the power of the dentist to solve the important eating problem so that his patient may enjoy his meals with comfort and assurance.

DISCUSSION

Virgil Simpson (M.D.), Louisville, Ky.: The human family can be divided into two groups, those who live to eat and those who eat to live. It is true in the large majority of cases that the individual who has lost his teeth eats to live to a greater degree than his more fortunate fellow because there is only a part of the pleasure of eating left to him. I am quite sure that the individual who has dentures has lost to some extent that relish in partaking of food which the individual possesses in his normal state. Those who have watched the lower animals during the preparation of food can readily appreciate the effect which the senses have on the organs that have to do with digestion of food. The watch dog lies beside the door when food is being prepared; his very mouth waters as he smells and, in fancy, tastes the anticipated delicacy. What is happening to his mouth is likewise happening in his stomach. In other words, the special senses aid in digestion. Any departure from the normal relationship of the organs of taste must lessen the appreciation of food. A patient needs the protein foods whether he is toothless or not, provided all things are equal, and the old quarrel between the vegetarians and those who are not vegetarians is not important. A certain amount of food is a necessity, and too much or too little of one of the required elements will bring about serious consequences. The body is so arranged that the individual can plan his own diet, provided that diet contains the necessary elements that go to keep that body in good condition. The food of the man who lives in the North differs from that of the one who lives in the South. Climate has much to do with it. The man who lives in the North must have more fats than the one who lives in the South, because more heat is needed to keep his body warm. One deprived of his teeth must depend more upon the preparation of food. The crying need of the country today is good cooks. It is most trying to see good, healthful, wholesome food destroyed in the kitchen. It is so easy to destroy good food in the preparation thereof. The dentureless individual can now have a full variety of foods as far as his needs are concerned, and the dentist has a field before him that has entirely, heretofore, been filled by the physician, in that it is not only his business to instruct his patient to do the best he can without his teeth, but it is also his function to teach his patient the best methods of feeding and to obviate the loss of his teeth. Hence, every dentist should be a dietitian to the extent that he understands the nature of the body, and to the extent that he can give advice that properly belongs to his dominion with reference to the education of his patient who has been relieved of the normal methods of mastication of food, and who must depend on artificial ones. He should know food values, he should be well acquainted with food preparations, he should make inquiry as to the general condition of the patient other than that produced by the teeth, whether he has some disease of the liver, or the pancreas or of other organs, that must be handled largely from the standpoint of diet. I listened with interest to get some sort of information as to what the dentists are learning with regard to the best kinds of food to keep patients from losing their teeth. A statement was made that a relatively small proportion lose their teeth because of local conditions. Heredity has much to do with this, and I am inclined to think that many people lose their teeth early because they could not pick their ancestors. Improper food during the formative period also plays a large rôle in the sequence of defective teeth in adult life, but local conditions still bulk large among the causative factors of premature loss of teeth. Pyorrhea is always with us. We are interested today with that group of conditions which go back of local issues and which destroy the heritage of sound beginnings. I wish to indorse most of what

Dr. Sears has said on what to eat and how to eat it. But may I say that the problem of nutrition is not solved when a given diet is ordered, when it is satisfactorily prepared, when it is properly eaten or satisfactorily disposed of by what is termed the digestive system. One of the most important phases of digestion is what is called cell digestion. Much of the evidence of malnutrition comes not necessarily from improper food, nor faulty preparation of food, nor from failure on the part of the digestive organs, as it may from failure of the cells in their use of food, and their inability to take care of it. That there is cell digestion can be easily shown in the laboratory. The first thing necessary is to inject into the peritoneal cavity of a guinea-pig a serum, say horse serum. Put the pig back in the hatchery and you cannot tell it from its fellows; it eats and sleeps and plays as do the other pigs. Let twelve or fourteen days elapse, and take this same guinea-pig and inject the same quantity of horse serum, and within a very few minutes a most spectacular phenomenon will present itself. The pig begins to show evidence of illness, and within five minutes convulsions will follow; it has an appearance of difficulty in breathing, and these symptoms become more and more serious, and the pig may even die. The explanation is a simple one; when the first dose of the serum was introduced into the peritoneal cavity without having gone through the digestive system, it was turned into the blood in its indigested state, and the cells not being accustomed to taking care of that kind of food begin to produce an enzyme to digest it. The protein molecule is composed of two elements, a toxic and a nontoxic one. During the digestive process, these elements are dissociated. The nontoxic one is used as food by the cell, while the toxic element is liberated. The process is a slow one while the cells are learning to adopt their activity to this new requirement, and the toxic elements are turned loose too slowly to cause symptoms. But when the second injection is given, the liberation occurs quickly because the cells are ready and the toxic elements are turned loose in a quantity to cause the symptoms described. There may exist in your patient an inability of the tissue cells to perform the final steps necessary for complete utilization of food, and malnutrition results. In other words, one may go hungry in the midst of plenty.

Dr. Sears (closing): Dr. Simpson made a point that the patient with dentures has lost his keenness for food. I doubt if that is true to the extent implied. I mean by that that there is a change noticed by the patient with a full denture at the beginning, but as the denture covers no part of the tasting equipment of the human being, there can be little difference in his caring for food. As we grow older we lose keenness in all respects, and we do not like our food so well whether we have dentures or not. Dr. Simpson touched on a subject that was not mentioned—the dentist's cooperation with the doctor. There is no one more willing to cooperate with the physician than I. I used to call up the physician, or make a visit to his office and say, "Mr. Blank is in my hands for treatment, what would you say as to diet?" Comparatively few members of the medical profession have gone into the subject of diet as affected by the patient's teeth. Furthermore, all physicians do not agree as to what is the right diet for individuals in general, and incidentally they may not agree with me, so that the better plan in my office has been this: "Mr. Blank is here for dentures and (for reasons which I tell him) I am advising such and such a diet. Are there any factors in this patient's physical condition that would make it unwise for him to follow this diet?" In nine out of ten cases the physician says, "Go ahead." No patient can chew so well with artificial dentures as with good natural teeth. When a patient tells you that he can chew as well with artificial as with natural teeth, he is fooling himself. Granted, however, that your patient could chew just the same with artificial teeth, it is wrong for him to do so because the supporting tissues are not constituted to bear vigorous chewing.

METHODS OF IMMOBILIZATION OF THE MANDIBLE IN THE TREATMENT OF FRACTURES*

By RALPH H. FOUSER, B.S., D.D.S., Chicago, Illinois

THE treatment of fractures of the mandible is governed by the same surgical principles applicable to fractures occurring in any other part of the body; that is, the bony fragments are to be placed in apposition, normal alinement and contour obtained, and the parts immobilized and placed in a state of physiologic rest.

Many methods and devices for the treatment of fractures of the mandible have been brought to the attention of both the medical and the dental profession, each purposing to apply to all types of fractures, and at the same time give the most satisfactory end-results, proper consideration of the patient's comfort being of major importance.

Prominent among such devices and methods may be mentioned the cast metal splint, the wiring method of Ivy, the celluloid splint of Dorrance and Gilmer's second method of wiring. The latter method offers the widest range of possibilities, and therefore is the one of choice in all fracture cases in which there are present a sufficient number of teeth in the patient's jaws. In only a small percentage of cases will direct wiring of the mandible be required, or will there be present an insufficient number of the patient's teeth to enable the operator properly to aline and immobilize the bony fragments by the use of the Gilmer wiring method.

Dr. Gilmer's method of treatment employs an upper and lower arch bar that has been properly shaped to conform to the buccal and labial surfaces of the arches, fourteen gage nickel silver wire, well annealed, being used for the arch bars, and 24-gage wire being used for the ligature wires that are passed through the interproximal spaces, forming a loop around each tooth that is wired. The free ends of the ligature wires, one end above and one end below the borders of the arch bar, are twisted to bring the ligature wire tightly around the tooth and the arch-bar. In this manner, the bar is firmly held to its proper position. Alternate teeth are used for the ligation of the bar to the teeth of the upper and lower jaw. Care must be taken not to ligate the teeth in the line of fracture.

After the upper and lower arch-bars are properly ligated to their positions, a double strand of the 24-gage ligature wire is then passed from one bar to the other, one in the molar region on either side and two in the anterior region being usually sufficient, and the teeth are brought to proper occlusion by the closing of the jaw. The intermaxillary or interarch bar wires are then tightened, holding the teeth in proper anatomic occlusion, which is the true guide for

*Read at the Midwinter Clinic of the Chicago Dental Society, January 28, 1926.

the proper alinement and contour of the bony fragments.

In fractures having no displacement of the fragments, owing to the periosteums not being broken, a single bar firmly wired to the lower teeth will usually be sufficient. The patient must exercise proper care in the mastication of food, and not partake of foods that require much stress in the process of mastication.

The same method may also be used with a complete arch-bar along the buccal and labial surfaces of the lower teeth and a small lingual bar in the region of the fracture, held in place by interlaced wire ligatures passed through the interproximal spaces, firmly attaching one bar to the other, as in the Hammond splint. This method of wiring may be employed if the fracture is in the anterior portion of the mandible and not much displacement is present, or in cases in which the teeth of the upper arch may be missing.

Conduction anesthesia with procain is usually sufficient for the reduction of the fracture, and, if necessary, a hypodermic medication of morphin, one-sixth grain and scopolamin, one-one hundred fiftieth grain, may be used as an adjunct to the procain.

Complete fixation must be maintained for at least three weeks, although the length of time for repair will depend on the patient's age, and physical condition, and the presence or absence of infection. A limited amount of movement of the fragments is permissible and stimulates fibrous attachment, especially in compound fractures when infection is present in the tissues.

Cleanliness of the mouth and teeth must be maintained by means of the toothbrush and the frequent use of an antiseptic mouth wash.

The patient's diet must consist of liquid or soft food when the intermaxillary wiring method is used.

In a review of case histories at the Cook County Hospital, it was observed that nearly all of the fractures occurring during the past five years were treated by the Gilmer method of wiring. Since about 250 fractures are treated annually at this hospital, this should be conclusive evidence that it has universal application, fulfilling the exacting requirements of an ideal method for the immobilization of the mandible in all types of fractures.

SUMMARY

The arch-bars are of 14-gage wire and the ligatures of 24-gage wire.

The interdigitation of cusps in central occlusion in each patient offers the correct guide for the reduction of the bony fragments.

Conduction anesthesia is used in reducing the fractures. Hypodermic injection of morphin and scopolamin may be used as an adjunct.

Complete immobilization must be maintained for at least three weeks or longer, depending on the local and systemic condition of the patient. A slight amount of movement of the bony fragments may often stimulate fibrous repair.

Cleanliness of the mouth and teeth must be maintained.

Liquid food is a necessity in all cases of intermaxillary wiring.

1747 W. Harrison St.

PORCELAIN—ITS APPLICATION TO FIXED BRIDGEWORK*

By J. E. ARGUE, D.D.S., Seattle, Washington

THE use of baked porcelain is adding to restorative dentistry a certain refinement, with a close approach to the ideal, and when it is properly understood, and the application of its principles are observed, a most hygienic and practical result is possible of attainment.

Cleanliness and the consequent health of the soft tissues in contact with smoothly glazed porcelain pontics, together with the beautiful esthetic result obtainable, most surely recommend for our consideration this type of fixed bridge operations.

The so-called dummy, with a porcelain facing and its gold attachments, made to set high against the labial or buccal surfaces of the alveolar ridge, forms grooves and shelves of various shapes, giving lodgement to food and the secretions of the mouth, which are very difficult to remove, with the result that a very unhygienic condition develops, usually causing a disease of the soft tissues around these bridges.

Modern operators are rapidly abandoning the use of this old type of construction and adopting a new type which consists of a dummy, modernly known as a pontic, having a highly glazed gingival end, which makes a contact directly with the crest of the alveolar border, the remaining surfaces being so anatomically formed with interproximal surfaces and embrasures that the patient can, with comparative ease, reach and clean every exposed surface of the bridge.

Credit is due Dr. E. T. Tinker, of Minneapolis, for one of the greatest advances made in restorative dentistry. It was he who, about twelve years ago, gave to the profession a complete technic covering this type of fixed bridge construction, and those of us who had the good fortune to recognize the merit and make use, later, of its underlying principles, have given a service greatly appreciated by patients, and most gratifying to the operator.

Like all meritorious systems that have been advanced, this one has been subject to considerable misconception and abuse. Many of these bridges improperly constructed, or placed where conditions contraindicate their use, have failed, not on account of any inherent weakness in the method, but because the operator had lost sight of the fundamental principles governing this every exacting type of bridgework.

In presenting this subject, I shall accentuate the Tinker technic for con-

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structing the porcelain pontic and, in addition, call attention to a form of porcelain pontic that may be used for replacing the lower incisors, cuspids, bicuspids, and molars, when we are concerned in producing a more esthetic result; and also describe a method of producing shades in the construction of the pontic that can be applied by resurfacing the labial, buccal and incisal

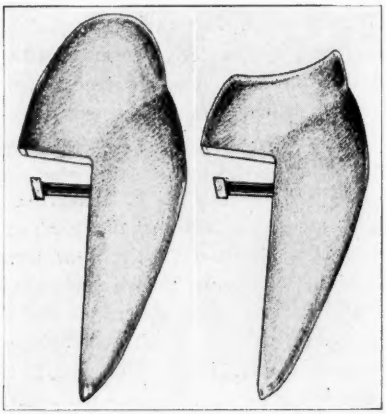

Fig. 1.—Porcelain pontics, showing Type 1, with root end form, and Type 2, with a saddle form that seats on the mucosa of the alveolar ridge.

surfaces of the facing, reproducing the proper variation of shades from the gingival to the incisal or occlusal to reproduce the shades of the teeth in the mouth of any particular case, as easily as producing the shades in constructing a porcelain jacket crown.

PORCELAIN PONTICS

There are two forms of the porcelain pontics. (Fig. 1.) The first is constructed with a glazed porcelain root at its gingival end about one-fourth to one-third the original length of the root of the tooth it replaces. The second is made with a glazed saddle that is fitted against the mucosa at the crest of the alveolar ridge. Obviously, in using this particular type, sufficient time must have elapsed after extraction of the teeth to be replaced, to permit of complete healing and settling of the alveolar tissues.

The first type has only a limited field of use, and should be confined to the upper and lower six anterior teeth, and not more than two approximating pontics should be placed in one case.

If more than two teeth are to be replaced, some form of temporary bridge should be constructed to serve as a substitute until the tissues have completely healed; then the second type of construction should be made use of, for the reason that if there is a great amount of recession of soft tissues around the porcelain root, later on, as there usually is in extensive cases, a much better esthetic result can be obtained, and a conspicuous porcelain root avoided, should the first type be used.

The second type is indicated when a greater number of teeth are to be replaced in the anterior part of the mouth, and should be used also, with but few exceptions, in replacing all teeth posterior to the cuspid.

CONSTRUCTION OF THE PORCELAIN PONTIC

The shade is selected and a bite impression taken of the case where the teeth are to be replaced. This is run up in a plaster mounting on some simple kind of articulator, so that an approximate occlusion of the opposing teeth can be obtained. If the teeth are to be extracted and the construction of the first type is to be employed, these plaster

teeth are cut away, and the plaster is drilled out with a large bur for the size of the root to be formed. If the second type construction is used and there is a ridge formed, that must be cut away to allow some bulk of porcelain to be built up at the gingival end, so there will be ample bulk of porcelain in which to grind in adaptation to the crest of the ridge.

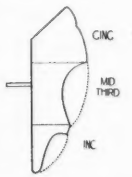

Fig. 2.—Long pin facing, with the labial surface divided into thirds, showing how the surface can be ground out to add porcelain of a deeper or lighter color.

BUILDING OF SHADES BY RESURFACING FACINGS USED TO CONSTRUCT THE PONTIC

For the higher artistic result in porcelain restorations, color is not the only essential, there being three factors that are interdependent: color, tooth form and the proper bake, which is given the porcelain to bring out that delicate translucency found in natural teeth.

Success depends chiefly on how carefully and accurately these three factors can be worked out in harmony. This applies principally in the construction of porcelain jacket crowns, and also applies to a great extent in constructing pontics for fixed bridges.

The variations of color in the natural teeth are many, and it is only when we make a detailed study of them that we get the proper conception of the high art essential to their reproduction. It is a problem that requires the development of a keen eye, with delicate perception of color arrangement, the principal arrangement consisting of deep underlying colors representing the dentin of the tooth and giving a blend of color from the gingival to the incisal or occlusal. This blend is never constant, but varies in each individual and also in every individual tooth of the same person, from a delicate blend that carries one color far into the other to, in some cases, an abruptness of blend in which one color ends about where the other begins, almost with a distinct demarcation.

These blends reflecting through the translucent plates of the enamel produce the principal color arrangement. Variations of this underlying blend are often found in certain teeth, principally in the region of the middle third of the tooth, in many cases giving a distinct mesiodistal line of some light or dark color in great contrast to the body color of the tooth; also, a deep color at the mesial and distal angles about the region of the incisal third. The latter is due, in many cases, to a discoloration that has taken place from some proximal filling operation. The enamel, aside from reflecting the underlying deep colors of the dentin, has a surface color that must be taken into consideration as a factor in the general color arrangement.

A most practical method consists in dividing the tooth surface into, say, the gingival third, middle third and the incisal or the occlusal third (Fig. 2), studying the color arrangement in these

given areas. The color that should be used to reproduce each separately, and which, when combined in thirds in their proper relation, reproduces a color blending from the gingival to the occluding end of the tooth.

The selection of color and the mixing of colors to produce others is a

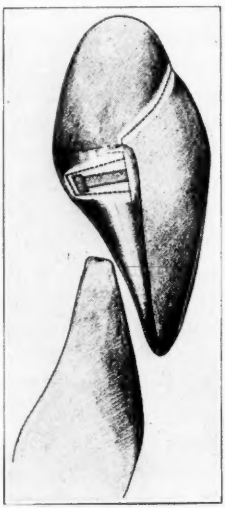

Fig. 3.—The pins with bar soldered across, showing how it locks into the backing when cemented, and their relation to the occlusion of the lower teeth to give the greatest strength.

highly scientific art. We should have a thorough knowledge of mixing the different colors and of the consequent shade produced thereby, as in no other way can we obtain a comprehensive understanding of what colors to combine and what not to combine in determining our color arrangement.

Dental porcelains are now available which make it possible to produce all the necessary shades that we find in the color arrangement of the natural teeth; namely, yellow, orange, brown, gray, blue and green, and also pink to represent the gum-tissue color.

Therefore, it is not necessary, in building colors with porcelain to mix any two or more colors to produce any other color. It is only necessary to mix different variations of shades to change a darker shade to a lighter hue of the same color or vice versa.

In this manner, one can vary the degree of color of the porcelain very readily, to match the color of any given area; for instance, the gingival, the middle or the incisal or occlusal third of the tooth; which places at our command a very broad range, and hundreds of artistic shadings of teeth can be reproduced.

Then, too, the eye must be trained; first, to recognize the color of any given area of the tooth; second, to modify the color of the porcelain to reproduce the degree of color of any area, and third, to combine color in order to give the proper blending from the gingival to the occluding surfaces; and, also, to reproduce the deep underlying colors and the surface color, finally.

In selecting facings, the regular shade guide, consisting of but few shades, is very inadequate in the average case.

So in selecting a color, I make comparison in thirds with the teeth in the mouth. In replacing a central incisor when the other central is to be left remaining, the latter should be used as a guide. A No. 7 tooth shade is placed beside this tooth, the gingival third, which may harmonize very well, being compared first.

The middle third may require a little

lighter hue, and, at the incisal third, the center of the incisal part may be a very good color, but needs a much deeper gray at the mesio-incisal and disto-incisal angles. When the comparison has been made, the changes necessary can be visualized and the probable appearance on completion.

A facing approximately the size is selected, in shade No. 7, and, with a white heatless stone, part of the porcelain is ground away, and the mesial and

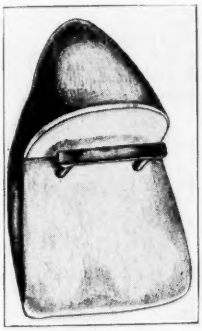

Fig. 4.—The form of the gingival tip and how it should be formed to fit to the cast backing. Thin cement is placed under the bar and pins and trimmed to a cone form, so the wax impression can be made, thus forming the box form in the impression.

distal angles on the labial surface are also ground. (Fig. 2.)

After the operator has decided what color should be used on the middle third in order to make it a lighter hue, and has also decided on the color to change the mesio-incisal and disto-incisal angles to gray, 2300 porcelain should be employed as this can be successfully baked on any facing without affecting the underlying form or color.

The middle third color and the mesial and distal incisal colors are mixed and built on, being contoured somewhat oversize. This will give enough bulk to allow for the shrinkage in baking. This is placed in front of the furnace to dry and is baked to 2440 degrees, long enough to bring this porcelain body up to a high biscuit only.

The operator now grinds to form and adds the tips on the facing that is necessary for the case. In the case of lower incisors and cuspids, the incisal tips can be built on at the same time the color arrangement is made, but in the upper teeth it is usually advisable to make a separate bake for the color.

As will be understood, this facing will not be completed until the surface enamel body is placed and given the proper glaze to reproduce the smoothness of surface of the teeth in that case. It reflects the underlying colors of the foundation body used in the facing, reproducing somewhat the same principle as the enamel in reflecting the underlying colors of the dentin. This is an example of a comparatively ordinary case, illustrating what can be accomplished in applying a definite technic to reproduce the color arrangement in teeth.

As there are hundreds of these color arrangements and blends of colors, we should train our eye to recognize and apply some method by which we can artistically produce an exact copy of arrangement of colors to harmonize with the human teeth.

Long pin facings are selected as near to tooth form and color as possible, and compared to the remaining teeth in the mouth, with the exception that, in selecting teeth to replace the upper six anterior teeth, an extra long tooth is

selected and the gingival end ground off, so that the pins will be located as far toward the gingiva as possible. Thus, a good space is obtained between the occlusal surface of the lower teeth and the pins. (Fig. 4.)

The pins are boxed in the backings, and when these pins cannot be set far enough gingivally in accordance with the occlusion, some 2440 porcelain of the proper shade is built down, the porcelain facing being thus made longer incisally. These pins are now shortened somewhat and squared up with a disk. A bar is cut 0.5 mm. wide from pure platinum of 30 gage, and this, then, is cut just long enough to reach across the two pins, and is soldered to the ends of these pins. (Fig. 4.) A simple method by which this soldering is accomplished is to apply borax to the bar and heat to red heat. A piece of pure gold, 36 gage, is cut into pieces 1 mm. square, and is used as solder. The bar is held at the center with a pair of soldering pliers, and a piece of this gold is placed on each end. It is now placed in the flame and the gold fused onto the bar. The pins of the facing, well covered with borax, are made ready and, before it cools, the bar is set quickly across the ends of the pins with the gold side away from the pins. This sticks readily to the ends of the pins; thus the annoyance of its falling off in handling, with a resultant waste of time, is avoided.

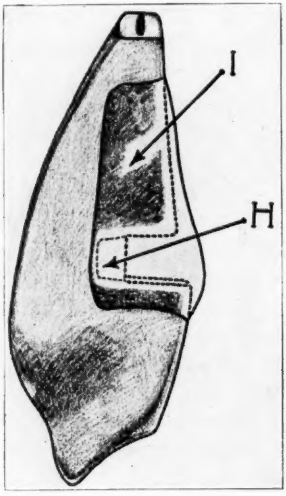

Fig. 5.—Lower incisor and cuspid porcelain pontic, made by reconstructing a steel facing; also form of cast backing, showing how it reinforces the porcelain from the occlusal stress coming from the upper anterior teeth.

This facing is now set, with its labial or buccal surface down, on a fire clay tray and placed in the furnace, and the heat is brought up to 2200. This fuses the gold nicely, which flows down over the bar and onto the pins, attaching them to the bar.

The gingival end of the facing is ground mesially, distally and labially, to conform to the outline desired at the gingival end. A strip of matrix material is set against the gingival side of the pins and against this the porcelain is laid.

I prefer some degree of yellow for this first gingival color, and I use 2300 porcelain for the building of all the gingival and incisal or occlusal tips, so that this can be resurfaced with a porcelain that fuses at a lower temperature, to produce a glazed surface without disturbing or changing the form of these tips that have been built up.

The porcelain is mixed with distilled water only, and should be only wet enough to flow to place and not run.

The moisture can be controlled with a strip of white blotting paper.

The porcelain is built up against the matrix, and also to form the type of tip the operator wishes to reproduce, only much larger in bulk, some allowance being made for the shrinkage that will take place when the porcelain is baked.

It is condensed well, and when the form is complete, the matrix is gently removed, a piece of blotting paper being held against the condensed body in doing so. If it should break on removal, it can be easily rebuilt by adding a slight amount of moisture to the mass, and carefully building on more body, producing the desired form.

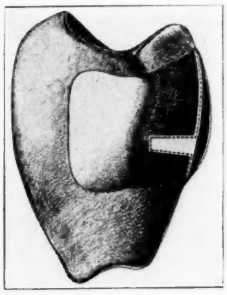

Fig. 6.—The form for a lower bicuspid and molar porcelain pontic; also the form for cast backing.

This labial or buccal surface is placed down on a tray, and it is set in front of the heated furnace for at least five minutes, to dry out thoroughly. It is then placed in the furnace at 1700 and baked to 2440 for about one minute. This brings the porcelain to a good high biscuit surface. It should then be cooled to 900 before removal from the muffle.

When cooled off, it is ground to the approximate form, a white heatless stone being used. A carbo disk is used to square up the shoulder next to the pins, which gives a very definite form; and with a small stone the edge is beveled slightly in order to give a fine edge to the gold casting. (Fig. 6.) That can be burnished down to the porcelain, making possible a close fitting joint, when cemented. (Fig. 7.)

LOWER INCISOR AND CUSPID PONTICS

The construction of the lower incisors and cuspids, I find, is the most technical of all, because, since they are smaller teeth, we have less bulk of porcelain for strength, and in addition, where facings with platinum pins are used, a certain amount of weakness results to the porcelain at that point. Therefore, I advise the use of steel facings for the lower anterior teeth.

The usual incisal and gingival tips can be built up with practically the same technic as that used in the pin facings. The facings are selected as nearly as possible to color and size. With a carbo disk, the lingual slot is widened somewhat, and the undercut groove is filled in with 2440 porcelain. (Fig. 5.) The color is selected for the incisal and also the gingival porcelain tips; and this is built up in the usual manner, with 2440 porcelain.

It is now ground to general form, and the incisal and gingival shoulder squared up and given a bevel. When the backing is formed, it is given the outline, being extended up to cover the mesial, distal and lingual two-thirds of the incisal porcelain tip. *H* shows the lug on the casting setting into the remaining groove of the steel facing. *I* shows the lap of gold extending up

on the incisal porcelain, reinforcing the porcelain against the occlusal stress from the upper anterior teeth, and protecting the porcelain from possible fracture.

LOWER BICUSPIDS AND MOLAR PONTICS

In some patients, the occlusal upper one-third and sometimes as much as the upper two-thirds of the lower bicuspids and molar teeth show, and in such

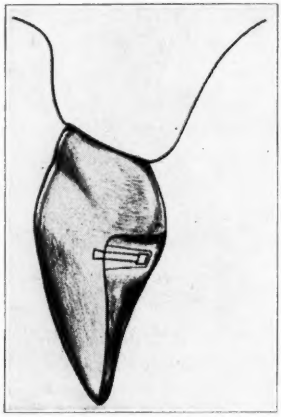

Fig. 7.—How Type 2 tip of pontic should saddle on to the mucosa of the alveolar ridge for the incisors and cuspids, convex mesodistally and concave labiolingually.

cases the esthetics should be considered. Provided there is ample space between the occlusal surface of the upper teeth and the lower alveolar ridge in this location for enough porcelain to stand the necessary stress of the occlusion, porcelain occlusal surfaces should be built, and the porcelain should be protected by the reinforcement of the properly formed backings. If the space is narrow and there is not room for a sufficient amount of porcelain, it would be advisable to use only the regular Tinker pontic with the cast gold occlusal surface and the porcelain tip, adapted in the proper manner to the alveolar ridge.

LOWER BICUSPIDS AND MOLARS CONSTRUCTED WITH A PORCELAIN SURFACE

Tube teeth of approximate size and shade are selected to fit the space, and these teeth are ground to conform to the occlusion and to the ridge, approximately.

Now, a cut is made in the lingual side with a carbo disk, about one-third the depth of the tooth. Then, with 2440 porcelain, the hole in the center is filled and baked. Then, the tip is baked on the gingival end to give it the proper form.

The backing, when cast, is given the form of the groove in the lingual and is made to cover the mesial and distal approximal surfaces, nearly to the occlusal surface, extending around also on the lingual in the same manner. This gives the sustaining support to the porcelain on the occlusal surface, from the stress of occlusion of the upper teeth, protecting this porcelain from possible fracture in the ordinary masticatory stress.

I have given in a general way the construction of the different forms of pontics which are made up to this point. The next step is to prepare the abutment teeth, and make and fit the abutments.

The impression is taken very accurately, the proper alinement of the abutments being given, also a good reproduction of the ridges, so that the pontics of the second type can be made

to adapt in a general way. If the pontic is of the first type construction, I take the freshly extracted tooth, and, with a carbo disk, cut off one-half the length of the root.

This tooth is now set in the impression and waxed to place before being

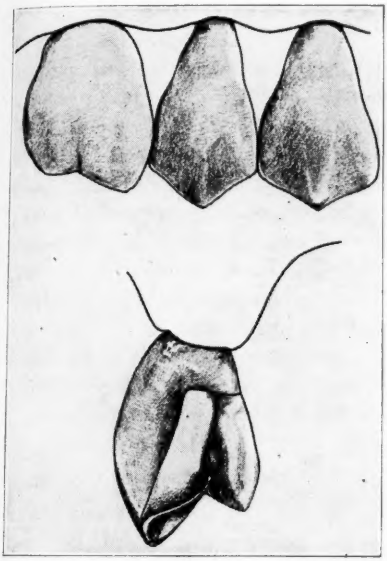

Fig. 8.—Type 2 pontic in the bicuspids and molars; showing the tip set more on the ridge with larger interproximal gingival spaces; which is much easier to keep clean with the brush.

run up in plaster. The models are mounted in a Monson or some other standard articulator in which balanced occlusion can be established.

This tooth is removed, then the pontic can be fitted into the socket from which the tooth has been removed, and the operator can be assured that, when the bridge is set to place, the root end will not impinge on the inner walls of the alveolar process.

The pontics are assembled on the articulator after grinding with a white heatless stone so that they will approximate each other, giving the proper interproximal spaces and contacts and, for the esthetic and artistic arrangement in the arch between the abutments, reproducing as nearly as possible the arrangement of the teeth in the patient's mouth.

Cement is mixed thin and placed under the bar and around the pins, where the pin facings are used, forming a box core. This reproduces a box form in the wax pattern to house the bar and pins when the pontic is cemented to the backing.

In case of a fracture of the porcelain at any time, a repair can be made much more easily where the pins are cemented in this way.

Wax patterns are now made for the backings, and cast and fitted to the porcelain. The pontics are assembled and the case is soldered, care being taken to add as little solder as possible, uniting the teeth at the contacts only, and having 1.5 to 2 mm. thickness of gold uniting the teeth, the solder being circular in form, with the contact point as its center.

This now is fitted onto the abutment teeth and set down to place, so that the operator may be positive that it fits properly.

FITTING PONTICS

For pontics of the first type, the bridge is removed only part way till the pontics can be slipped to place. Then the bridge is again set down to place, and, with a very fine broach, we start at the labial of each pontic and insert the broach between the alveolar

wall and the porcelain root, passing the broach completely around its orifice. In this way, we can readily determine whether the porcelain impinges on the alveolar wall at any place. If it is found to impinge at any point, it should be removed and ground till the root will go to place with a free space between the alveolar wall and the porcelain.

In pontics of the second type, saddled onto the healed mucosa of the ridge, the assembled bridge is set to place, and the pontics are fitted by grinding the gingival end of the porcelain so that it may saddle tightly onto the mucosa of the ridge. In the anterior teeth, it should extend slightly labiogingivally and upward lingually a little over the crest of the ridge. This gives an esthetic result. The tooth is ground considerably narrower mesiodistally than the tooth it is replacing; which allows more clearance for cleansing this surface. It is also found that the gum tissue assumes a much better esthetic form in these gingival interproximal spaces. (Fig. 7.)

In molars and bicuspids, we must consider principally the hygienic result; so, in fitting the pontic in this location, it is recommended that the porcelain be ground to saddle with as small an area as possible against the crest of the ridge, which gives a good clearance mesiodistally. It is adapted very snugly so that when the bridge is set to place, it will blanch the tissues well, showing that it is contacting with pressure. (Fig. 8.)

In all cases, fitting the pontic after the bridge is assembled places at your command the opportunity to grind any of these pontics to the proper approximating form to the tissues, and also to correct any tooth form that has not come up to your ideal. Tooth forms sometimes look different when assembled in a bridge and set in the mouth. These can be corrected by grinding on any surface necessary, as, you understand, all these teeth are to be resurfaced and reglazed to a finished surface.

When the pontics are all ground to the necessary form, establishing the highest art in form and arrangement, the bridge is removed, and if there has been recent extractions, the fresh alveolar socket is carefully washed with some antiseptic wash and packed with a mix of "wonder pack," by incorporating a few fibers of cotton in the mix, in order to make the mass easier to place in the alveolar socket.

The patient is now dismissed for a day or two until the bridge is completed.

RESURFACING THE PONTICS WITH PORCELAIN BODY

The pontics are washed and placed in the furnace and heated to about 2,100 degrees to volatilize the impurities from their surface, and cooled, and they are ready to resurface.

In resurfacing, I use a medium fusing body, and what we wish to accomplish is to get a highly glazed gingival tip that contacts with the soft tissues, and, of course, such a surface would not be correct for the labial, incisal and occlusal surfaces, as it would give a surface to the porcelain tooth that would not harmonize with the teeth in the mouth. To accomplish a more desired result, a small percentage of 2,440 porcelain is added to the medium fusing porcelain, and mixed well on the

glass slab. This is used on the exposed surfaces of the pontic, and the medium fusing porcelain is used alone on the gingival tip.

The result is that, when it is baked, bringing the medium fusing only on the gingival tip to a high glass glaze, the remaining surfaces, where we have a percentage of 2,440 incorporated, will only fuse to the desired smoothness required in order to compare to that of the surface of the teeth in that individual's mouth.

The shade is selected in the enamel body for the different thirds, and if the case is one requiring the replacing of a lower incisor or cuspid teeth, and these require an incisal stain in order to match the stained dentin, where we have a surface wear on the incisal, and the dentin has taken on considerable stain, this can be secured by grinding a groove with a small No. 6 garnet stone on the incisal end of the incisal tip, the same size as the stained area of the teeth in the mouth. A deep shade of yellow or brown is built in to match its color, and is then baked.

When the enamel body is built over this and baked, the desired result will be obtained and the color will not wear off.

The pontic is held, where there are pins, by the lock pliers, and where there are no pins, a piece of orangewood can be fitted into the slot in a way to hold quite firmly.

It is necessary to have some means of securely holding the pontic, as little can be accomplished when it cannot be held firmly while resurfacing.

The porcelain body is first placed on the gingival tip. It is then built toward the incisal or occlusal, and on the labial, on these surfaces, the tooth form necessary, copying the forms of the teeth in that individual's mouth as nearly as possible in form surface markings and color, with a layer of porcelain that will only cover the surface nicely when fused.

This is now set on the proper kind of stand in front of the heated furnace, to dry out, for at least five minutes. It is set in the muffle at about 1,000 degrees, and heated and baked at 2,300 degrees, just long enough to obtain the glazed smooth surface.

The root end, being of lower fusing porcelain, takes on a very high glaze, which is necessary where porcelain comes in contact with soft tissue.

This is allowed to cool down to about 700 or 800 degrees before removal, to obviate checking of the porcelain.

The pontics are now fitted to the bridge and cemented to place.

The bridge is given the final detail finish and polish. It is then cemented permanently to place on the abutment teeth, and the case is completed.

Where the pontic of the first type is used in the construction, I advise the patient to return every twenty-four hours, in order to wash out the alveolar socket with a sterile, warm, saline solution, using a Luer syringe, with a hypo point that can be inserted upward along the root without injury.

This is recommended until the cellulitis has entirely subsided, and the healing of the socket is well established.

The instructions to the patient for cleaning the bridges in the mouth should be practically the same as for cleaning their own teeth.

By using a gingivo-occlusal rolling motion, extending the fibers of the

brush into the interproximal spaces well, then following with four or five rinses, with warm water, to flush out all spaces perfectly, a hygienic condition can be maintained.

DISCUSSION

Horace G. Whittlesey, Mexico City, Mexico: Although Dr. Argue leans just a little on the side of esthetics, we will do well to follow the technic given by him. Dr. Tinker, in giving this type of bridge to the profession, left little to be improved on. No other type of restoration gives so much comfort to the patient and satisfaction to the operator. It is the one type of bridge, either fixed or removable, that most nearly approaches cleanliness. It will remain cleaner, in spite of neglect on the part of the patient, and I have seen cases in which it was the only clean place in the mouth, with the adjacent soft tissue in a reasonably healthy condition. This result may be obtained only by following a definite technic, and will not permit of any abuse or carelessness, as Dr. Argue has warned us. His manipulation of porcelain is well thought out and is worthy of consideration. By using more porcelain in our work, where indicated, we shall be taking a step forward, and the result will be much more beneficial and pleasing to our patients, as well as more gratifying for us. Discussing Type 1, I believe the tendency among users of it is to shorten the porcelain tip, and I would caution the operator never to make it longer than one-fourth the length of the natural root. As good a result, from an esthetic point of view, can be obtained with even shorter tips. Regarding the second type: I am inclined to get away from the saddle, and would recommend the spheroidal form. I consent to the use of the first type merely for esthetics, and I agree with Dr. Argue that it is only practical for the six anterior superior teeth, where some sacrifice may be made for appearance sake. In the bicuspid and molar region, we can get a natural aspect and assure a comfortable feeling for the patient, and also a more hygienic condition, by giving the tip somewhat the form of a marble, which will reduce porcelain in contact with the soft tissue to the minimum. While the soft tissues take kindly to highly glazed porcelain, the result of contact is a low grade tissue. Where we have short teeth, there is no choice. It is often impossible to get a shade in a facing that will harmonize with the natural teeth, and, quite frequently, when it can be done, the artistic appearance is destroyed by grinding to give the desired form, or to bring the pins to their proper place. I have tried staining with both gratifying and disappointing results. A beautiful result can be obtained with china paints, but it is not permanent, as it will wear off in time. At times, I have been compelled to grind the facing and rebuild on account of distance from a good supply house; but by careful selection of facing, this can generally be avoided.

In the anterior teeth, it is necessary to have the pins of the facing as far cervically as possible, just as Dr. Argue said, because the pins must have bulk in the gold backing. Regarding boxing the pins in the backing: I had never considered it necessary, and as it means more time consumed, I should want a very good reason for doing so. Dr. Argue says it is easier to repair. Is there any other reason? I am not familiar wth the use of the incisal tip for the six inferior anterior teeth, but I can see the advantage of it as the gold backing is frequently quite unsightly and anything but artistic.

Bicuspid and Molar Pontics Constructed With a Porcelain Occlusal Surface Using the Tube Teeth.—I believe the Twentieth Century tube tooth is made of higher fusing porcelain, is stronger, and also will permit refusing much better. We must have sufficient space to give bulk of porcelain unless we wish to spend our time repairing, which is unsatisfactory for the patient as well as oneself. In constructing the gingival tip of the pontic of Type 1, the technic of extracting the tooth and placing in the impression, cutting off the root and building the porcelain root in the socket of the model, is excellent, and an ideal result may be obtained, because, if the tip impinges at any point on the alveolus, absorption is almost sure to follow, and we defeat the end for which we are striving. The only disadvantage, as I see it, is that the patient must, for about two days, have a tooth missing in a very conspicuous place. Regarding cutting mesiodistally anterior teeth for Type 2, I would caution against exaggeration, as we cannot hope to have the interproximal

space fill in with soft tissue and it leaves a space between the teeth which not only looks bad, but also causes some discomfort to the patient on account of air passing in and out. I have had this complaint and been compelled to change the teeth for wider ones. I would recommend care being taken not to touch the glazed porcelain with stone or disk, as it leaves a roughened surface, which is more difficult to keep clean, and if at a point of contact with soft tissues, will many times cause an inflammatory condition. I cannot give a favorable report personally on staining except for mottled teeth. To get the general blend and harmony of colors with the natural teeth, I would favor resurfacing with porcelain. We must take into consideration, however, in baking porcelain that a thin layer of porcelain will not give as deep color as one of more bulk. It is good practice to narrow the facing mesiodistally as much as possible, if lapping the crest of the soft tissue; but immediately on leaving contact with soft tissues, it is better to have as small a space between the teeth as possible and still enough to permit cleanliness. In making the gingival tip, I use platinum from 30 to 33 gage, placing it on the facing as if backing for an old style dummy, then placing the thumb nail or an instrument just above the pins, and bending the gingival end of platinum lingually, and by placing the porcelain tooth on the model in the position it will occupy in the finished bridge, we can mark shape and size desired, judging by the size and shape of the remaining teeth. This enables one to condense the porcelain tip very well and easily. If I am not mistaken, this is the original Tinker technic.

C. O. McBean, Los Angeles, Calif.: If for no other reason than the hygienic results obtainable with the baked porcelain restorations, this type of restoration should appeal to every conscientious operator. The wave of condemnation of fixed bridge restorations which swept over the profession some years ago would never have occurred had the same precision been followed in the construction as is absolutely necessary in the construction of a removable restoration, giving the case proper consideration from the anatomic standpoint, as well as those of hygiene and occlusion. When due consideration is given to the mechanical principles involved in the two types of restorations, we are impressed with the fact that, in applying the principle of fixation, we have only taken away from the floating piers the movement from mesial to distal, or from distal to mesial, the piers still having full function, when the line of force is from lingual to buccal, or buccal to lingual, as well as when the line of force is apical. Therefore, the elimination of but one of the four or five functional movements, with the subsequent functioning of the fibers of the peridental membrane is not sufficient to interfere materially with the circulation of the peridental membrane. From the foregoing argument, and clinical observation, we know that fixation alone does not produce absorption or pathologic processes. Giving consideration to the mechanics of a removable restoration, if it be of the male and female type of attachment, with the saddle resting upon the mucosa, the male attachment is slightly elevated in the female, so that when force is applied to the restoration in the act of mastication, the frictional surfaces of the two attachments impart force to the pier, and, at the time of complete seating of the male attachment, an additional force is communicated to the pier, which, in mechanics, would be termed a knock. A knock in a piece of machinery is the mechanical engineer's greatest concern. Let us consider the effect of this on the peridental membrane. Those of us who have observed closely the effects produced in placing a gold foil restoration know that, if the plugger point is placed loosely in contact with the gold, and then force is applied with the hand mallet, and this procedure is continued to the completion of the restoration, the patient will complain of the tooth being very sore and elongated, which is due to the inflammation produced in the peridental membrane. On the other hand, if the operator, in placing the plugger point in contact with the gold, exerts considerable pressure before the force of the mallet is applied, the operation will produce no inflammation in the peridental membrane. This proves that the tissues will not tolerate certain types of knocks. As all frictional surfaces in contact will, in due course of time, wear, the removable restorations of necessity will require frequent adjustments, and if these adjustments are neglected, the saddle will produce irritation of the mucosa, with subsequent absorption. The case now may be compared

to a fixed bridge which has become uncemented, and continues to be worn. They both would assume the principle of a mechanical lever, and either act as an orthodontic appliance or produce further destruction. With these facts in view, it would seem advisable to give earnest consideration to the type of restoration which the essayist has described, but a thorough understanding must be had of the principles involved; which are, proper occlusion and proper anatomic form of the pontics. The pontics should be formed on the buccal and lingual, so that they will deflect the bolus of food in the act of mastication, away from the gingival contact of the pontic, with the mucosa, permitting the food to make a free excursion over the tissues, without lodging and packing around the gingival contact. The pontic should have sufficient space in the embrasures to permit the easy cleansing of these surfaces, by the patients. The soldering of the different units of the truss, as Dr. Argue has stated, should be confined to the contact points. The porcelain that comes in contact with the tissue must have a highly glazed surface, whether the pontic is of the first or second type, as described. In order to produce the desired surface, whether this is accomplished by using a lower fusing porcelain on the tip or by producing the proper condensation and firing of the porcelain, used as the body of the pontic, the operator must have a definite knowledge of the physical and chemical laws involved, combined with the mastering of a definite technic, in the manipulation and firing. Without this knowledge, he will, all too often, produce a porcelain that is full of pits, bubbles and carbon specks; which produces a rough surface in the porcelain, no matter how highly glazed the latter may be. A porcelain, the surface of which is rough, will defeat our purpose, for as stated, the tissues do take most kindly to a perfectly smooth, highly glazed porcelain, and will remain perfectly healthy around a pontic so constructed, while they will not tolerate a rough or pitted porcelain. I wish to emphasize the point that the first type of pontic, or the so-called porcelain root, should never come in contact with, or impinge on, the alveolar process; nor should it be long enough, or extend into the socket sufficiently far to interfere with the normal regeneration of process in the socket. It is, therefore, a safe policy to construct the pontic root no longer than one-quarter of the length of the original root. The porcelain root should always be blunt, and only slightly convex on the apical end, and should never be constructed peg shaped or sharp at the apical end. The porcelain root type should be used only in cases in which the supporting tissues of the teeth are normal, or practically normal. If there is decided recession of the soft tissues, this type of pontic should never be used, or, if in the extraction, or from other causes, the labial or palatal plates of process have been severely injured or destroyed, the porcelain root pontic is contraindicated; for, if employed, the absorption that will inevitably take place producing a most displeasing appearance. Therefore, where these conditions are present, the butt type of pontic is indicated.

Where the porcelain root pontic is used, the span should, as stated, never be more than two teeth; but I have employed this type many times in replacing the first and second bicuspids, with very pleasing results. The results obtained, when it was used where indicated, are most gratifying to both patient and operator. The color problem, or so-called shade of the teeth, probably gives the dental ceramist as much concern as any other factor. As stated, the different parts of the tooth vary in interpretation of shade, as well as each tooth differing from its adjoining neighbors, and, if observed closely, the interpretation will vary at different times of the day. This is not due to the changing or failing eyesight, but is the result of the operation of a scientific physical law. Teeth present different shades under the varied conditions that they are subjected to; for example, an upper, central incisor, which is of a yellowish cream color, when the lip is retracted will shade to a gray, or a bluish gray on the incisal tip, or that portion of the tooth which is exposed to view when the lip is in rest position. The intensity of the graying of the incisal third, or tip of the tooth, will be determined by the thinness of that portion of the tooth, as well as the intensity of coloring of the lip, combined with the effect produced by the dark oral cavity. If a white napkin is placed back of this same tooth with the lip well elevated, it will be found that the gray, or bluish gray, will not be present in the tooth. I find it advisable to take the shade of the gingival

third, with the lip well retracted, and the incisal and middle thirds of the tooth covered with a piece of white card. Then, with the lip still retracted, and the middle and gingival thirds of the tooth covered, I obtain the shade of the incisal third. The middle third will generally be a blending of these two colors. For that portion of the incisal of the tooth which is exposed to view, with the lip in rest position, the color is determined with the lip in rest position. As the patients spend but a small percentage of their time in bright day light, it seems also advisable to chart the shades of the tooth under artificial and subdued light, then produce a shading of the restoration that will harmonize under all these conditions. As I have never found two shade guides made by the same manufacturer that absolutely correspond in color, I have therefore found it advisable to make a shade guide of the various porcelains that I use; as, for example, a 2560 degree porcelain, condensing and firing a slab of each of the various shades of this porcelain by the same technic employed in building the restoration, the slab being about the same thickness as the porcelain in a veneer restoration. With a shade guide of this nature, it is a simple procedure to select the shade of the tooth, as described before. The labial surface of an upper central incisor presents, on close inspection, grooves, pits and ridges, as well as many fine markings, which produce facets. These break up the high lights, by reflecting part of the light at such an angle that the rays are not received by the eye. At these points, there will be an appearance of graying of the color of the tooth. This effect may be produced in the porcelain restoration, by either carving these markings, or by grinding them in the porcelain, before giving the glaze firing. I agree with all the principles of the Tinker type of pontic, but I prefer to construct the pontic for the upper teeth, without the use of the pin facing, by building the pontic of a 2560 degree porcelain and producing a cast occlusal truss which extends over the two approximal surfaces. The buccal cusp of the pontic is beveled sufficiently to permit finishing the casting to a feather edge, over the buccal cusps, still retaining sufficient bulk of the cast to protect the porcelain. The lingual cusp is ground off sufficiently to permit enough bulk of the occlusal casting to give rigidity to protect the lingual cusps of the porcelain. Through the center of the occlusal portion of the porcelain, a groove is cut about 1 mm. deep, and extended on to the two approximal surfaces in a similar manner to that of a mesioclusodistal inlay, except that the casting is finished to a feather edge at the gingival and is not seated to a gingival wall. Further, the extension bucally is not sufficient to expose the metal to view from the buccal. A dowel hole is constructed in the occlusal of the porcelain pontic, extending apically about two-thirds the thickness of the porcelain. The type of pontic described by Dr. Argue for the lower posterior teeth is strongly indicated. On this type of pontic, I prefer placing lock grooves on the two approximal sides, rather than cutting the groove into the lingual side of the pontic. The pontic thus constructed will seat from the occlusal, and the metal truss on the lingual side will be at right angles to the line of force, brought to bear on the buccal cusp of the porcelain pontic. The points in regard to resurfacing the pin facings with 2300 and 2100 degree porcelain should receive very favorable consideration, for the highly glazed surface of the pin facings, devoid of all of the markings which the teeth of the individual case may have, impresses one with the fact that it is an artificial tooth, as soon as the eye is focused upon it.

COMPARATIVE STUDY OF THE MERITS OF NITROUS OXID AND ETHYLENE-OXYGEN ANESTHESIA FOR ORAL SURGERY*

By J. A. HEIDBRINK, D.D.S., Minneapolis, Minnesota

IN comparing ethylene anesthesia with nitrous oxid anesthesia, it is necessary to bear in mind that ethylene is a comparatively new anesthetic. Nitrous oxid has been used for three quarters of a century, with ever increasing popularity, while ethylene has been used but two years. The number of anesthesias in which ethylene was employed is small indeed as compared to the number of nitrous oxid anesthesias, so that any conclusions reached at this time may not be well founded, and it may be necessary to revise our conclusions from time to time as experience is gained with ethylene. Then, too, ethylene as received from the manufacturers today may be improved on, since it is claimed by some that absolutely pure ethylene is odorless, and that recently improved methods of manufacture have seemingly removed some of the offensive odor.

Any objection there may be to the odor of ethylene at the beginning of induction may be avoided by inducing anesthesia with nitrous oxid-oxygen and then switching to ethylene, or ethylene with nitrous oxid. Ethylene may be administered with nitrous oxid in any proportions desired. Dr. J. S. Lundy, of the Mayo Clinic, highly recommends the use of four gases, nitrous oxid, ethylene, oxygen and carbon dioxid. One method is to induce anesthesia with nitrous oxid-oxygen and then add 5 per cent carbon dioxid, or as much as is needed to keep the respiration strong, continuing the anesthesia with either equal parts of nitrous oxid and ethylene in quantity to supply breathing, or with just ethylene. The four gases so used produce a beautiful anesthesia with plenty of latitude for carrying the patient through the average case. I have found that equal parts of ethylene and nitrous oxid in quantity to supply breathing with 10 per cent oxygen and 5 per cent carbon dioxid produce a surgical anesthesia in exactly the time required for nitrous oxid-oxygen; that is to say, in a large majority of cases the time is about the same, as nearly as can be determined, and in most cases the anesthesia was maintained for tooth extractions without indications for changing the mixture.

In many respects, nitrous oxid and ethylene are quite similar in their action. The time required for inducing anesthesia is approximately the same. There

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is little difference in the degree of comfort to the patient and the sensations produced during induction. Both anesthetics are quickly eliminated, ethylene possibly a trifle more slowly than nitrous oxid. I might say that ethylene, being a lipoid solvent, will be absorbed by the fatty tissues, and it may take days for complete elimination. A patient may taste or smell ethylene for two or three days. I am speaking about the immediate recovery to consciousness when I say it is proportionately the same, a little longer possibly for the ethylene. As far as the systemic effects of the two anesthetics are concerned, it appears that nitrous oxid and ethylene may be considered equally safe. The difference between the oxygen requirement with ethylene and the oxygen requirement with nitrous oxid is not so great as was at first believed. On apparatus the dials of which are calibrated for nitrous oxid, the indication of flow is not correct for ethylene, and the increase in the percentage of oxygen is apparent rather than real, because ethylene flows through a given aperture much faster than does nitrous oxid, so that while the indicator shows 2 gallons per minute, the ethylene will be flowing at a rate approaching 3 gallons per minute, and the indicated increase in oxygen will be merely proportionate to this more rapid flow. Ethylene anesthesia can be maintained with a higher percentage of oxygen than with nitrous oxid, probably because ethylene is a little more powerful in its anesthesia effects, produces more muscular relaxation and permits a somewhat wider anesthesia range. Therefore, ethylene anesthesia is more placid and more easily maintained with the patient's mouth open.

Ethylene is a splendid anesthetic for children. Because of their high metabolism and consequently higher oxygen requirement, their anesthesia range is narrowed. Ethylene will usually carry them in anesthesia without the appearance of symptoms of oxygen lack such as are more or less frequent with nitrous oxid. Children can be safely and satisfactorily anesthetized for our work with nitrous oxid, provided consideration is given their limitations, and an attempt is not made to get them to be quiet or relaxed.

The pronounced symptoms produced by nitrous oxid in advanced anesthesia stages, such as color changes and jactitation, are lacking with ethylene. Therefore, deeper stages of ethylene anesthesia are less alarming to the anesthetist of limited experience. This is a questionable advantage of ethylene, for the reason that the very pronounced symptoms of the deeper stages of nitrous oxid anesthesia is an added element of safety. The symptoms are unmistakable, and undesirably deep stages of anesthesia are more readily avoided.

Because ethylene is more powerful in its anesthesia effects, possibly more of the resistant types of patients can be carried safely through anesthesia than with nitrous oxid. This difference is not so great as was at first supposed. Ethylene will not satisfactorily anesthetize many of the more resistant types without premedication.

The increased relaxation obtained by the use of ethylene is also of questionable value when administered for mouth operations. Because of the greater re-

laxation, the mandible is more easily forced back, or drops back, and breathing is restricted. It is usually necessary that the mandible be held forward. Also, the epiglottis, being relaxed, permits entrance into the trachea of blood or of mucus, the secretion of which is seemingly more profuse. More anesthesias are interrupted by strangling, and there is noticeably more violent coughing on awakening. Interference with breathing is much more frequent and serious than with nitrous oxid. For most of our operations, it is not necessary that the patient be relaxed. With nitrous oxid, sufficient reflex is usually retained to prevent mucus or blood from entering the trachea. With ethylene, more careful throat packing is imperative.

While ethylene cannot be exploded in the tanks, when liberated in concentrations upwards of 5 per cent it is explosive, and precautions must be taken that there be no flame or sparks from electric switches or motors in the room to ignite it. This precludes the use of the dental engine, if one is disposed to use an electrically operated bone chisel or drill. Nitrous oxid presents no such hazard unless ether or some other explosive gas is used in combination.

To date, the deciding factor in choosing between ethylene and nitrous oxid for routine use has been the difference in the recovery experiences of the patient. Many complain of the odor and taste of ethylene, and a larger proportion of patients are nauseated and the nausea is more distressing and prolonged. When ethylene is administered to patients who have previously taken nitrous oxid, some will express themselves as entirely pleased with the experience and are apparently unaware that they have taken a new anesthetic. A greater number make a comparison decidedly unfavorable to ethylene. Some complain bitterly of the nausea and of the odor and taste of ethylene which remains with them. A recent patient anesthetized with ethylene remarked that she had traveled a considerable distance because on three previous occasions she had so pleasantly had gas administered, but that she could not understand why it affected her so differently this time. Her nausea and depression required that she remain in the office for four hours.

It is conceded that a patient might have an uneventful recovery on one occasion and a distressing experience on another, with the same anesthetic. Nevertheless, nausea occurs with such regularity with ethylene that it leaves no room for doubt that it occurs much more frequently than with nitrous oxid.

My experience with ethylene is limited to administrations numbering in the hundreds only. The thousands could not be reached for the reason that each of the various times I have adopted it as a routine anesthetic, the distressing after-effects, in so many of the cases, caused me to discontinue before any great number of anesthesias had been administered. Each time, it seemed that the slight advantages offered by ethylene over nitrous oxid were more than offset by the disadvantages, and the continuance of its routine use could not be justified from the standpoint of the patient. The more I use ethylene, the more I realize what a good anesthetic we have in nitrous oxid.

As I have said, in view of the limited experience with ethylene and its newness these conclusions should be considered as indicative rather than final. My present use of ethylene is limited to such patients as prove too resistant for quiet or satisfactory anesthesia with nitrous oxid, when ethylene is added or a complete switch is made to ethylene. In some of these cases, ethylene will smooth out the anesthesia; in others, the results are disappointing.

DISCUSSION

E. L. Moravec, Cedar Rapids, Iowa: Although the number of ethylene anesthesias have been few as compared with nitrous oxid, the study of ethylene has been far more intensive, owing to the fact that we have nitrous oxid anesthesia as the base line for comparison with its many years of study and administration back of it. I believe that our present conclusions as found in Dr. Heidbrink's paper are dependable. The advantages as numerated in this paper are, I think, offset by the disadvantages in a comparison of the two anesthetics. In my own practice, I have worked rather experimentally with ethylene from almost the time of its discovery by Dr. Lockard, secretly, for a number of months. At times, I felt that we had a superior anesthetic. While I have had no accidents, no unpleasant results, I confess I have never felt so completely at ease under all circumstances while administering ethylene as I have with nitrous oxid. I have worked along the same line of experimentation and with the same machine as Dr. Heidbrink and have reached much the same conclusions. I am using in my office practice the ethylene *only* as a synergist to nitrous oxid in the most obstreperous cases, and I find it has a little more "knockout" in that way, possibly owing to the fact that there is a greater flow of ethylene under the same pressure than of nitrous oxid. As to the after effects comparatively, I can see little difference; the difference possibly favoring nitrous oxid. In my hospital work in general anesthetics, I find my surgeons rather skeptical of ethylene, and they prefer ether as a synergist, if one is necessary. Also, I use as a routine a prehypodermic of morphin one-sixth grain and atropin one-one hundred and fiftieth, which ensures that our patients enter the operating room in a more quiet state, and also overcomes the immediate postoperative pain, since our patients are so quickly back to normal after gas anesthesia. This dose is varied according to the type of patient, increased for athletic types and decreased for emaciated types. I can see no advantage of ethylene gas for children or emaciated patients, as in those cases we have sufficient anesthesia in nitrous oxid-oxygen. I also believe our danger signals are more easily interpreted under nitrous oxid, and it is therefore safer in the hands of the untrained. At all times, we should be prepared to meet any emergency, whether cardiac or respiratory, by proper stimulants or artificial respiration. Far the greatest number of deaths are due to respiratory failure, and this being true, the logical theory is—stimulate the respiratory centers. Artificial respiration and oxygen inhalation are valuable. These can be facilitated by the addition of crystal alkaloids. The outstanding objection to ethylene may not be the positive explosive danger, but the thought of it is disquieting, to say the least. As to the unpleasant odor, that is negligible when it is used only as a synergist, and I believe that eventually it will be overcome in the manufacture of the product. Ethylene merely gives us a greater selectivity of anesthetics, and we are still looking for the ideal anesthetic.

Joseph P. Wahl, New Orleans, La.: I believe that we have no right to offer so much condemnation to an anesthetic that has been of such a recent discovery. For instance, as Dr. Heidbrink said, nitrous oxid has been used for a great number of years where ethylene has been used for only a few years. Dr. Moravec says that an anesthetic should not be used by untrained men. No man who is untrained should take the responsibility of giving an anesthetic no matter what it is. The operator has no right to give a general anesthetic. We have given quite a good deal of ethylene in our office and up to date I

must say we have not had these terrific explosions. We knew that the ethylene was highly explosive. We took every precaution to try to prevent explosions. It wouldn't be well for a man to run a motor in a suction machine in an office where he is using ethylene unless he has it thoroughly isolated or protected. Any little spark from dust or anything else getting on the brushes might ignite the ethylene. Dr. Caine, who gives as many anesthetics as anybody, states that he has had only two explosions and they were of minor effect. One was due to negligence. I might say both were due to negligence. I think in one case a man walked in with a lighted cigarette. In the other case, the operator had a lighted burner off in a corner. Neither of these accidents were of any consequence. The patient's hair was singed a little and the anesthetician's arm was burned. The gas mask was blown up, or something of that kind. I believe I have noticed several advantageous points in ethylene anesthesia, one of which is that there is less struggle under ethylene anesthesia than with nitrous oxid. I have also noticed that the period of induction is almost the same. There is one point greatly in favor of ethylene. The patient doesn't have headache as an after effect as he does with nitrous oxid. I have never had any patient complain about tasting or smelling ethylene a day or so after anesthesia. Ethylene is a safer anesthetic to use on children than nitrous oxid. With every child to whom I give nitrous oxid anesthesia is forced. There are very few exceptions. In various hospitals throughout the country, ether is being used on that account. It is claimed that the struggling results in excessive respiration and causes postoperative pneumonia. Dr. Heidbrink spoke of the necessity of packing the throat, in connection with the ethylene anesthesia. This is a very good practice in all cases of general anesthesia. I have seen some serious terminations through the teeth slipping down the throat, etc., causing pulmonary trouble. I don't see why we should fear to give ethylene on account of its explosive property any more than we fear to ride in a train, because an accident occurs once in a while. I believe that ethylene is going to be one of the greatest anesthetics. I don't say it is going to be used in place of ether or nitrous oxid, but I believe it is going to find a place in the anesthetic field.

J. P. Henahan, Cleveland, Ohio: As I have had only a limited experience in the use of ethylene, I do not feel entitled to discuss its use from a practical point of view. There are, undoubtedly, many objections which can be raised against its use, objections based upon the history of its employment to date. However, there are many serious minded men carrying on experiments in its use and to these we owe a full measure of consideration. The professions are going through an experience similar to that of years ago when ether and chloroform were first used. There were objectors and enthusiasts. The subsequent history has shown that there was ground for the stand of both sides. There has been much success in the use of each, and there have also been many accidents. The only way to judge ethylene is by its record. We know that it is extremely explosive. We also know that it is a lipoid solvent and that its action in many respects resembles the action of chloroform. The ideal anesthetic has not been discovered, nitrous oxid and oxygen, with its difficulty of administration; ether with its disagreeable properties, and chloroform with its paralytic effects leave a place for an agent which will eliminate these features. If ethylene is an improvement on any or all of these, we want to know it, but as yet we have not known it long enough to determine. When chloroform was first introduced, it was heralded as a panacea for all anesthetic troubles, but the sudden death of a young girl, during the performance of a simple operation, dampened the enthusiasm for its use and resulted in more careful consideration of its use. Ethylene may prove a great addition to our list of anesthetics, or it may prove to be a very dangerous addition. It is still in the experimental stage.

Dr. Heidbrink (closing): Dr. Moravec stated that there had been more extensive experimenting with ethylene than with nitrous oxid at any time. I would remind him that the advancement made in the methods and technic of administering nitrous oxid-oxygen

during the past fifteen years is certainly indicative of extensive developmental work. I agree that our anesthesia practice will be much more pleasant and satisfactory if we do not try to operate in every case under nitrous oxid. For physiologic reasons, an occasional patient is not a good subject and would have a stormy time under any general anesthetic, especially with no premedication. Performance of some of our operations under a general anesthetic is exceedingly difficult for most of us. Some patients are adverse to taking a general anesthetic. All these matters should receive due consideration when selecting the anesthetic. As regards the medication of patients prior to anesthetizing with nitrous oxid, I believe all patients are benefited by suitable premedication. It is especially desirable for those who are unusually resistant to the anesthetic. Because so many of our patients come for immediate operation without appointment, and because so little difficulty is encountered in anesthetizing and operating in the average case, premedication is often neglected when most needed, and anesthesia difficulties for both patient and operator are unnecessarily increased. The breath-holding test that has been suggested as a means of determining the patient's fitness for taking an anesthetic has never appealed to me as being of any great value. This test may be misleading. It is my experience that there is great discomfort from long holding of the breath. The discomfort is considerable during even the first half of the breath-holding period. The inaccuracy of the test lies in the uncertainty as to how much discomfort the patient will endure before he resumes breathing. Try holding your breath by the watch. You will find you can hold it for a considerable time after the discomfort is very great. In a healthy individual with an unusual dislike for punishment the breath-holding period might be very short. Some one remarked about the high percentage of untrained anesthetists. It occurs to me that, in the field of anesthesia, none of us ever quite complete our training. "Trained" is only a comparative term, and it ill defines the point at which the anesthetist might be judged competent to practice anesthesia. We all had to make a beginning. We older men must recall the poor beginnings that we made, when the generally accepted method was to suffocate the patient and then try to finish the operation before the awakening. Today, quite definite methods and technics have been worked out, and, together with much comprehensive literature on the subject of anesthesia, are available to the beginner, and he commences miles ahead of where we started. His results are correspondingly better and he can hope for more rapid progress as he gains experience. Today, there is opportunity for only a comparatively few beginners to administer nitrous oxid-oxygen under direct supervision of a competent anesthetist. Those who can should lend their assistance in teaching where possible. Dr. Wahl mentions some precautions to be taken when using ethylene. I would add that, when possible, it is desirable that a window be opened in order that a draft through the room may carry off any explosive vapors that might otherwise accumulate. I am not quite sure that Dr. Wahl fully appreciates the danger of an explosion with ethylene. Always the unexpected may happen and the spark of flame be supplied to ignite any explosive mixture should it accumulate in the room.

FOCAL INFECTIONS FROM THE STANDPOINT OF THE INTERNIST*

By WILLIAM A. JENKINS, M.D., Louisville, Kentucky

WHEN infectious material (micro-organisms) gain entrance into the human system, the infection follows one of two courses: 1. After a brief incubative interval, it produces immediately a general or systemic invasion, a systemic disease, in fact. Examples of this type of disease are typhoid fever, scarlet fever and pneumonia. 2. The infectious agent finds temporary lodgment, usually in some organ or structure adjacent, or near to the portal of entry. Here, it goes through a period of a low grade existence, producing some local changes, colonizing and multiplying. Later, after months or years, it may invade one or more of the important internal organs or structures of the body and produce grave and even fatal disease. This second course constitutes focal infection as we now understand the term.

We now know definitely that focal infections are the cause of many systemic diseases heretofore very obscure to us, especially from the standpoint of etiology or origin. This illuminating and far-reaching truth has exerted a profound influence throughout the fields of diagnosis, prognosis, therapeusis and prophylaxis.

It would be well at this point to consider the mode of action of focal infections and to study the factors that influence them and are responsible for their varied and diverse manifestations.

First, as to their mode of action: Focal infections produce systemic effects or harm by one of two methods, and in many instances by a combination of the two methods, acting simultaneously.

(a) All focal infections manufacture and throw off into the general circulation of the host soluble toxic substances, or toxins. These toxins exert a deleterious influence on the entire system, producing such symptoms as headache, muscular soreness and pain, loss of weight, fatigue, malaise, a slight rise of temperature perhaps, and vague intestinal symptoms. The patient is always conscious of a feeling of being subnormal, unfit or unwell, without any definite explanation for this condition. Such symptoms usually precede, for considerable periods of time, systemic implantation or disease. Oftentimes, the doctor's advice is sought even in this early stage. (Allow me to say in passing that we doctors of medicine are all too prone to pass over such cases lightly. If such a group of symptoms persist, and we can find no adequate explanation, we are justified in making a thorough and exhaustive search for possible foci of infection.)

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In a great percentage of our cases, the above described group of symptoms persist and are superadded to the picture after certain internal organs or structures become definitely involved.

(b) There are certain factors that influence focal infections and are responsible for their varied and diverse manifestations. To discuss this subject in its broadest aspects, in its entirety, would require too much time, and it would also lead us too far afield from our immediate subject. It is however, permissible, even in a practical paper, to enumerate and discuss, although briefly, such facts and principles as may be shown to have a direct and definite bearing on the subject in hand.

In the consideration of the growth, life, reactions and characteristics of any living organism, whether it be large or small, microscopic or macroscopic, made up of one cell or a multitude of diverse cells, simple or complex, there are but two factors of importance; namely, endowment (the seed) and environment (the soil). This postulate holds good for the infected individual, the human host, and also for the particular organism producing the given infection. Heredity, or the seed, furnishes the genetic or racial characteristics, the basic qualities that are more or less fixed (at least as far as the purposes of this article are concerned). Basically speaking, it is heredity, an inborn, inherited quality of the seed, that keeps a zinnia a zinnia and a rose a rose. A streptococcus remains a streptococcus. It has certain morphologic and cultural characteristics, certain inborn, inbred possibilities that it cannot transcend. The streptococcus may change to a certain extent its behavior, its method of living and acting, just as man or any other biologic entity may. It can never, however, become a pneumococcus. The converse of this proposition is also true. Biologically speaking, this is what we mean by heredity. Certain infectious agents that produce disease and even death in man have no power whatever to produce harm in certain of the lower animals, because these animals are inherently protected; not, however, through any action on their part.

Micro-organisms have certain morphologic and cultural possibilities that pertain to them alone. Their form, arrangement, their method of producing changes in culture mediums, etc., are characteristic and specific for that particular strain. Bacteriologists can recognize and classify them from the foregoing traits alone. Also, these organisms have the power of attacking certain members of the animal kingdom, producing certain definite changes or diseases in the organs and structures of these animals. Now, the above mentioned changes and diseases are so characteristic that clinicians are able to recognize them clinically (grossly, without microscopic examinations), and say "this is probably a streptoccocic infection, or this a tetanus bacillus infection," etc. The above named characteristics are inborn, hereditary or endowment manifestations; inherent qualities of the seeds themselves, and as such are, comparatively speaking, fixed.

The environment, or the soil is the second great factor in determining the qualities and possibilities that any living organism may manifest or exhibit. Environmental factors exert a powerful and important influence on the life and activities of any living organism. In fact, viewed from a local and species

standpoint, which is rather narrow, environment would seem to be overwhelmingly important. Some scientists, working only in a narrow field, are prone to make environment the chief, or even the sole, factor.

Certain disease-producing organisms are activated and made more virulent by passing through a series of individuals. On the other hand, infections may have their virulence weakened and decreased by being subjected to certain factors, no matter whether these factors are artificially prepared in the test tube, or are naturally encountered in the human or other animal body; e. g., smallpox, a dreadful disease while passing through a series of human subjects. Now this same virus attacks cows and sheep. As cowpox and sheeppox, in the above mentioned animals, it produces disease manifestations of no great consequence, yet the virus is identical in its nature. Environmental factors have changed temporarily its activities and outward manifestations. In our bed of zinnias, we may observe one plant which exhibits a variation, it may be of color, size or shape. The florist and horticulturist call this specimen a sport. Now if we carefully save the seeds from this specimen and plant them in a favorably situated, rich bed and keep this process up for a few generations, discarding all plants which tend to revert back to the parent stock, we will in time fix the characteristic, and behold we have a new variety, which to one unacquainted with flowers might readily be mistaken for a new kind of plant. It is, however, only a zinnia, having the same coarse stem, the same rough hairy leaves and the same strawlike, but gaudy and handsome flowers. Take the streptococcus, for example. Streptococci taken from the roots of teeth in individuals who have kidney disease with stones present, when injected into rabbits produce kidney disease in the rabbits. Yet we may take streptococci from the surface of the mouth or throat of the same individual and inject them into another rabbit and they will fail to produce kidney disease. What makes the difference? Environmental factors only. In the one case, namely, that of the teeth, the organisms have been living in an oxygen-poor environment for a long time. Also, they have been subjected to the influences of the tissues and fluids of the human body in a very intimate way during this long period. On the other hand, those taken from the mouth are only slightly influenced by the reactions of the body fluids and cells of the human host. An abundance of oxygen is available. Consequently, the organisms are as yet not so markedly influenced by environment. Whenever micro-organisms find a location in the human body, they immediately begin to act on or produce changes in that same body, and conversely they, in turn, are reacted on by the cells and fluid of the human host. All of the complexities of this same action and reaction are not understood by us and probably never will be; yet we have learned enough about the matter to establish certain facts that have become the basis for the science of immunology. From studies in this field grew Dr. Rosenow's principle of specificity (as related to focal infections and involvement secondarily of certain internal organs). Take measles, a very common disease, and, as a rule, under ordinary circumstances, rather mild among civilized peoples. Because of the frequency of this disease we, as a race,

may be said to have acquired a certain amount of immunity, and also the virus, the seed, has lost somewhat in virulence. On the other hand, when measles is carried to an isolated district, say an island inhabited by aborigines, it becomes very virulent and kills its victims by the hundreds. A healthy body, well-functioning endocrines, a strong well-balanced nervous system, perfect metabolism, clean living and healthy surroundings are all soil, or environmental, factors, and so on *ad infinitum*.

Thus we see that wrapped up in these two factors, the seed and the soil, endowment and environment, we have the adequate explanation of all possible combinations encountered and formed when these two factors are brought together. If we understood all the elements in these two factors, we would at once possess the key that would unlock the secrets of all focal infections.

Both experience and observation teach us that, of the whole group of infectious diseases that kill or cripple large numbers of our population every year, at least from 80 to 85 per cent, gain entrance into the human system by one or the other of two common routes; namely, the upper air passages and the oral cavity (the mouth). This being the case, it is at once apparent that this whole subject is one of prime importance. Not only is it necessary for us to observe strictly all the known and valuable rules of hygiene and sanitation as they apply to diet, habits and right living, the purification of air, the cleanliness and preservation of all substances intended to be used as food and drink, but also it is equally important to observe frequently and keep in a healthy condition the organs and surfaces of the upper air passages and the mouth. The first of these measures, by a carefully conducted campaign of education, and even by legislative enactment, has been brought to a fairly high state of effectiveness. This, however, does not hold good as regards the necessity of frequent observation and keeping in a healthy condition the organs and surfaces of the upper air passages and the mouth. While it is true that, in a great many of our large cities, we have health clinics and inspection of school children as regards the condition of the nose, throat, mouth and teeth, these examinations are conducted only at long intervals and in a hurried manner, and are given only to a relatively small number of the total population. There is no intended criticism of this work. It is a move in the right direction. It is good as far as it goes. The only trouble is that it does not go far enough. It should be more thorough, more frequent and more widespread in its application. It should apply equally to the child and the adult, the urban and the rural population. The tonsillar-adenoid and allied structures are more likely to become diseased, and hence a focus of infection in the period of childhood, and, becoming involved in childhood, they may, if not removed, continue to be a menace throughout the adult period. If, on the other hand, these structures escape infection up to the adult period, the likelihood of their becoming diseased decreases relatively. Primary infection after this period is, of course, possible, but not common.

Infections about the teeth and gums are a menace to an individual throughout the entire period of life, or at least throughout the life of the given individual's teeth, from the time the teeth

first begin to appear until they have all been removed, either by artificial or natural means. In view of these facts, it seems strange that we pay so little attention to the teeth. How commonly do we see children with gum boils, red, sore gums and five or six hollow blackened shells of teeth, with inflamed gums surrounding them, and the parents usually say, "Oh, those are the milk teeth, they do not amount to anything. They will soon fall out anyway, they need no attention." This is most emphatically not true. These teeth are very important; they have a definite purpose to serve. Diseases of the teeth and gums in children interfere with proper mastication and insalivation. This interference, long continued, gives rise, first, to indigestion, and later to disorders of nutrition, and favors the implantation of serious infections, either from the original focus or from other sources. Mr. F. W. Acland, chairman of the dental board of England and Wales, recently stated that, of the six to seven millions of children attending the elementary schools of England and Wales, 86 per cent suffered from bad teeth, with an average of five bad teeth per child. He also stated that at least 85 per cent of the total population under 20, and an increasing percentage over that age, were suffering from dental diseases. For fifteen years, I was the physician in charge of a children's home of about 500 inmates. During that period, my own experience with diseased conditions of the teeth and gums was, roughly speaking, about on a par with that of the examining board above mentioned. I have had secondary infection or involvements of the joints many times; in the heart, a few times; in the kidneys, occasionally; all of which goes to prove that the teeth in children should be given proper and careful attention, just as much so as should the adult's.

Irreparable damage may be done to the structures of the mouth during the period of the deciduous teeth. The seed may be sown then, but the harvest will come later.

Perhaps the greatest damage from infections of the teeth and adjacent structures comes with the adult period. My own case records and my experience in general medicine of well over a quarter of a century warrants the statement that, from the mid-period of life onward, the above mentioned structures would perhaps stand at the head of the list of the so-called foci of infections.

According to the estimates of a prominent English Life Insurance Co., one-half of all the illness found in the industrial classes is directly due to the teeth. In my own work, I make it an invariable rule to institute a careful examination of the mouth and teeth of every case that is sent to me for a diagnosis, including a complete roentgen-ray examination if indicated. This matter is just as important as is an examination of the heart or the lungs. A few months ago, a patient came to me with a history of long standing, intense pain located in the lower jaw, left side. The teeth were pronounced sound and the cause was thought to be systemic in origin. Careful physical examination failed to account for the condition. I had the jaw bone examined by roentgen ray. An unerupted impacted molar was found. After its removal, the symptoms all subsided. Again, a patient came to me with a multiple arthritis and evidences of systemic toxemia. The local doctor said that the teeth could not

be the source of trouble in this instance, as he had had a dentist remove all of the diseased teeth some months before sending the case to me. Careful roentgen-ray examination of the lower jaw, where the teeth had been removed, revealed a considerable area of rarefaction with beginning necrosis of the bone. Curettement, drainage and removal of all dead bone were instituted, a slow but finally a complete cure resulting. The question of what to advise concerning dead teeth has always been a problem with me. Dead teeth are foreign bodies in the mouth. I think it is an open question as to whether they can be rendered and kept sterile or not. They should be looked on as a constant menace and they should be watched at all times. It has been proved again and again that devitalized teeth may be negative radiologically speaking, and yet they may harbor streptococci or other disease producing micro-organisms in the apical region. I would not go so far as to say that all devitalized teeth should be removed, but I do say that teeth should not be devitalized whenever it is possible to prevent it. All devitalized teeth should be examined carefully and frequently and they should be examined by the roentgen ray periodically. Frequently, I see some wonderful bridgework, and, on close examination, I find the fastening points or abutments of this work resting on badly diseased teeth. Evidently, the aim of the dentist has been, in many instances directed entirely toward mechanical efficiency and cosmetic effects. Now these things have a place; they are important, but they should not be the chief concern of the dentist. In the future the slogan of the dentist should be "The prevention of oral sepsis in the human mouth." The medical profession has sadly neglected this matter and has failed to recognize its significance and its consequences. This is one of the greatest problems of preventive medicine, and we have as yet only scratched the surface of it. We doctors of medicine must get to work on this great problem and we must call to our aid our skilled fellow-workers, the doctors of dental surgery. We must stand shoulder to shoulder in this matter as equals, without jealousy or bickering, and, furthermore, we must demand and secure the hearty cooperation of an enlightened and intelligent public. When this shall have been accomplished, we shall be able, in a great measure at least, to prevent disease and premature death, prolong life and increase and sustain the period of human usefulness.

DISCUSSION

J. P. Corley, Sewanee, Tenn.: I wish to ask Dr. Jenkins what he means by a dead tooth. There is no such thing as a dead tooth, as long as there is a vital connection between the pericementum and the periosteum. My brothers of the medical profession (and I am a graduate of medicine myself) have gotten the term "dead teeth" fixed in their minds and to my way of thinking it is responsible for more tooth loss than any other catch-word or phrase that has ever been in vogue. This frenzied vogue of tooth extraction has done more harm to the profession of dentistry and to the public than any other sophistry for which we have fallen. Is it not possible, in a majority of the cases of pulpless teeth (if we spend the time and used the skill at our command) to clear up the infection without the loss of teeth? It could be done nine times out of ten, if we received twenty-five or fifty dollars for our root canal work. This is a modest sum when we measure it with the value of the service given. We could save 90 per cent of them, and we would make a greater contribution to society in the way of health than we could make by

extracting them and leaving the patient dentally crippled or by substituting cess pools in the way of mechanical restorations.

W. H. O. McGehee, Cleveland, Ohio: It is a well recognized fact that there are two sources of nourishment for a human tooth: one, by way of the pulp, the other, by way of the peridental membrane. When we remove the pulp from a tooth, we still leave in position the peridental membrane, which still furnishes a certain amount of nourishment to the root of that tooth. Consequently, the phrase "dead tooth" is a misnomer. If this paper had been read before an organization of dentists ten years ago, it might have proved of a good deal more interest to us as scientific members of the dental profession than it has this afternoon. The subject of focal infections has been discussed by the medical profession and by the dental profession, now, for a number of years, and we feel that any man in the dental profession who reads the literature of his profession is thoroughly intimate with all of the points which have been brought out this afternoon.

Dr. Jenkins (closing): I have purposely made my paper practical or utilitarian, feeling that by this means I could reach the needs of the greatest number. In this paper I have had two chief aims in view. First, I have emphasized the necessity of the doctor of dental surgery and the doctor of medicine working together as co-workers in the same field. To obtain the best results, it is absolutely necessary for the above mentioned classes of workers to be in absolute harmony and to cooperate at all times. Second, I have attempted to make a few emphatic and truthful observations on dead teeth. I notice that a number of the audience do not like this term. I ask you, what shall we call them? and from a number of points in the audience comes the answer "devitalized teeth." When a thing is devitalized, it is deprived of life, and when it is deprived of life it is most certainly dead. Therefore, it will either be necessary for you gentlemen to change your conceptions or your nomenclature. From my point of view, whenever a tooth is entirely and completely pulpless, I shall continue to call it a dead tooth. From my personal experience, I feel sure that this practice of removing the pulp from the teeth is resorted to in a great many instances when it is neither necessary nor justifiable. The dentist says to the patient, "Now I will remove the nerve from this tooth, fill it for you and you'll have no more trouble." I always feel that dead teeth are a menace to the patient. They are practically little more than foreign bodies in the mouth. It is true that the peridental membrane furnishes a slight connection with the tooth. Its possibility for doing that particular tooth any good is almost nil. On the other hand, micro-organisms contained within the recesses of the tooth or deposited in the tissues around its roots now find a most excellent opportunity to grow, multiply and throw off toxins in the general circulation. In other words, it forms an ideal point for a focal infection. In the young, this is perhaps not so bad, but in those who have reached middle age it is another story. They are now in the degenerative period of life. Decalcification is taking place and dead teeth, if present, will give trouble sooner or later. Under such circumstances, they should be watched clinically and examined by roentgen-ray occasionally, for possible trouble. In my own experience, in very many instances I have encountered marked cases of arthritis. Roentgen-ray examination of the mouth shows dead teeth negative to roentgen-ray examination. In many such instances, where I could find no other satisfactory focus, I have had the dead teeth removed, and, on culturing the teeth, have found green-producing streptococci present, and have had the satisfaction of seeing the arthritic condition clear up entirely inside of a few weeks. I feel very strongly about this matter and I believe that the conclusions that I have drawn in my paper regarding such teeth are in the main correct.

RESUME OF THE ENTIRE PROBLEM OF DENTURE CONSTRUCTION, INCLUDING EDUCATION AND TRAINING OF PATIENT*

By I. V. DUELL, D.D.S., Louisville, Kentucky

DENTURE prosthetists have never been so deeply concerned nor so wisely busy as now. All honor to those who have studied, thought, planned and contributed to uplift our branch of the profession and benefit the people whom it is our duty and privilege to serve. We are indebted to all who have contributed in any way to this laudable purpose by way of contributing better interpretations, improved methods and better instruments.

We are sorry to see in the *Dental Items of Interest*[1] that the secretary of the "Round Table," has been, out of touch with the progress of our work. It is hard to overestimate the ill-effects of expressing opinions by playing with words without a fair understanding of advances made within the last decade.

In contrast, there is the statement of Dr. Robert R. Gillis[2] that "nothing but the ignorance, carelessness or lack of application on the part of the operator, can now deny comfortable and efficient prosthetic dentures to the edentulous patient."

In my résumé of the clinics, papers and discussions presented here, permit me to say just a few words about the men and their work.

Dr. Horner's offering is an account of detailed technic of procedure. He gives us the methods by which he is solving the problems arising in his daily office practice. He actually practices what he preaches. Another important thing that Dr. Horner is presenting to us is the method by which he leads the patient to a greater appreciation of better denture service. In this aspect of our work, there is a crying need and to be able to gain an insight into the education of the patient in this regard, from actual practice, is indeed valuable.

One of the pioneers in our special field of endeavor is Dr. Randall, who was among the first men in this country to take Professor Gysi's courses. For a period of twenty years, his efforts have been directed along educational lines. He has been mentor to many of the men who have become prominent in the prosthetic field. The salient points he has given us here are the need and

*Read before the Section on Full Denture Prosthesis at the Sixty-Seventh Annual Session of the American Dental Association, Louisville, Ky., Sept. 24, 1925.

1. Dent. Items Int., August, 1925.

2. Gillis, R. R.: Articulator Development and the Importance of Observing the Condyle Paths in Full Denture Prosthesis, J.A.D.A. 13: 3 (Jan.) 1926.

value of sane classification and, expressly, the consideration of tissue resiliency, which is one of the latest factors brought to light for consideration in building better dentures.

Remembering that no two cases are any more nearly alike than any two cases of the surgeon, who would not be guided in his operations on the second patient by the diagnostic records of the first, we, as dentists, should not attempt to construct dentures without first intelligently diagnosing the condition of the foundation upon which we are to work, and systematically charting the condition found. We should then carefully consider what other steps of importance are to be undertaken and whether the results that we hope to attain will actually give the patients what they are spending their time and efforts to secure, namely: comfort, masticatory efficiency, esthetics and phonetics. Dr. Charles Lane estimates that, during a five-course dinner, 3,000 bites are taken. Whether this is mathematically correct makes little difference. We know that the amount of stress produced each twenty-four hours is great, and by no method can the denture be built to serve successfully unless a base is selected that will sustain this stress. How can we, in this day of enlightened opportunities, fail to lend every effort to make the patient's interest paramount, and so reap the honor accruing from successful work? Let it be remembered that the big things we are prone to spend our lives looking for are only a culmination of little things, that no one step in denture construction is more important than another. Careful and thorough study and understanding of each step, just as though there were no other step included between the diagnosis and the final milling, will make the assembling of all a pleasure rather than drudgery, with doubtful results.

Another of our number behind whom lies extensive experience in research work is Dr. Howard H. Jackson, who is noted for his work in regard to calcium concentration in bone as revealed by the radiogram. His interpretation of radiograms used in both full and partial denture work gives us another advance in the coordination of radiography and prosthetic work.

Little more than a decade ago, patients expected to remain dentureless for from six to twelve months, but who, in these modern times, wants to stay in confinement, daily losing facial contour, waiting for Nature to do the work that can be done by the oral surgeon at once? Modern denture construction demands surgery of the highest order. An oral surgeon who is really a trained prosthetist will make an intense study of the mouth from the prosthetist's standpoint before he begins to operate and will visualize the ideal mouth condition that he is about to produce. How many of us can visualize the functional elements of the anatomy of the oral cavity that are going to make for the success or failure of our dentures? Hence, as Dr. Jackson states, the need for radiograms.

In the further consideration and care for the welfare of our clientele, Dr. Sears has contributed valuable data in relation to the patient's mastering the manipulation of dentures. His extensive work on the subject of diet has

enabled him to point out to us the most suitable foods on which to initiate the edentulous patient.

Perhaps in no other work has the subject of impression technic and material been so broadly presented, with a recognition of the varied individual requirements, as in the work of Dr. Weir. We can truly appreciate the exhaustive way he has treated the subject, when we see how he justifies the use of the various materials according to the requirements of individual conditions.

There is no one in the profession better qualified to read such a proclamation of emancipation as that contained in the opening remarks of Dr. Tench's paper. His paper gives us a concise and practical detailed technic, something tangible that we can take home with us and use to solve the problems in our own practice. Hereafter, discussions relating to arbitrary and adjustable theories of condylar movement may well be termed the "controversies of yesterday." Dr. Tench's paper rightfully sounds the death knell of the arbitrary theory.

There is a slogan that has been made popular in the business world that reads "ask the man who owns one." In this respect, the work of Dr. Boyce bears with it much value from personal experience. His knowledge gleaned from many a denture course makes him peculiarly qualified to deliver us such a weighty message.

A student of art spends two-thirds of his time in studying the materials with which he is to work, and the remaining one-third of his training is devoted to the technicalities of working the materials of which he now knows the nature. Is not a knowledge of our materials equally important? This is a matter that is frequently overlooked. A logical reason for each procedure should be the rule. No matter how perfectly the mouth has been prepared, all can be ruined with a haphazard impression; for the impression molds the base to be worn over the tissues. The impressions once obtained correctly should be boxed, poured and separated with equal carefulness, due consideration being given to the materials. Know whether time and thermal change will affect them, and how. At this point of our journey, we take in a partner—our patient. She cannot help you make the contour occlusion rims, arrange the teeth, vulcanize the rubber, or mill the occlusion, but she can certainly assist you in suggesting her facial contour and in deciding how much service to sacrifice for appearance; while, on the other hand, you will assist her in deciding how much appearance she can sacrifice for service.

Selecting and arranging the teeth demand the utmost care and judgment. Every tooth has an individual character and expression, and must be in harmony not only with every other member of the same mouth, but also, by the same law, in harmony with the features and character of the individual.

It must be remembered that, in Nature, there is a great beauty in the irregularities; or, what is called the ugliness in shape and color often constitutes a prime factor in a pleasing individuality. The fact that an even row of very white teeth is considered ideal does not prove that such teeth suit

everybody. From infancy to old age, there is harmony in contour as well as in color, and there is correlation of one with the other at every stage of life. The hair that would be becoming to a girl of 16 would not be suited to the same person at 60; hence, Nature changes the color of the hair to be in keeping with the face, as age advances. The same is true of the teeth: all change and grow old together, and there is beauty in age only as there is harmony.

Dr. Joseph Richardson once said, "Among the unnumbered millions of human beings who have peopled the earth since the dawn of time, it may be affirmed that no two have been created with faces exactly alike. There is the same aggregate features and a pervading general resemblance of one person to another, but there will be found as infinite a multiplication of distinct shades of facial expression as there are human faces, and each separate shade of expression characteristic of each one, distinguishing him or her from all others, constitutes facial individuality."

I would not be interpreted as discrediting the technical ability frequently displayed in constructing dentures, but I believe observation of denture-wearing patients will prove the following statement: The proportion of good artists who could have made good technicians is very large; while the proportion of good technicians who could have made good artists is very small. Conditions of the past will, in the future, improve in direct proportion to the attention given to art in this department of practice. Thus, the prosthetist who hopes to enjoy his work must render maximum service to those investing confidence in him, and should be a man of great artistic conception, with a true sense of the proportion of things and of the harmony of color.

Therefore, Drs. Owen and Bruening in their paper have treated their presentation on the subject of hue and color in such a way that those familiar with the contents of this paper will have a better basis on which to judge color harmony in full denture work.

Mr. Hanau's work, as presented at this meeting, is of outstanding merit because of the exhaustive way in which he has treated his subject. Perhaps no one, except Dr. Gysi, has ever laid before us such a comprehensive treatise on the fundamental laws. I would suggest that each one here present, if he desires to simplify his articulation problems, study Mr. Hanau's laws of articulation, thoroughly.

Even when this is all done and the dentist has given years of time, grounding himself in a knowledge of anatomy, physiology, materials and technic, his work is not yet finished. An equal knowledge of psychology is yet demanded. The patient is being given something very abnormal when the attempt is made to trade a portion of the natural anatomy for an artificial substitute, suddenly inserted in its place. Here, he needs a sincere and sympathetic guide. In my experience, the time and place to begin this guidance is in the first sitting. Patients are no more interested in anything a dentist can talk about than the solution of this, their own problem. Picture to them the principles of technic involved in such manner that they may conceive and

perhaps solve mentally some of the intricacies associated with the use of dentures. Logical and sincere explanation and reasoning, well directed, at each sitting, serves to gain cooperation that otherwise might never develop. Make your patients copartners and never treat lightly their suggestions or remarks, no matter how erroneous. They generally are offered in a spirit of cooperation, rather than criticism.

A story of an old physician, whose son had just graduated in medicine and was ready to take his father's practice, relates that in the course of the man's advice, he said: "Son, if you are ever called to administer to a grandchild of an old lady and she insists upon helping you diagnose the case, don't ignore her, but listen well, for while she has not studied medicine as you have, she has reared more children." Sometimes I think this is equally applicable to the dentist who seems to believe any complaints are made in a spirit of perverseness. The patient has not studied denture construction, but he has worn more dentures than we who have been blessed with our natural teeth, so do not ignore his ideas, but listen and listen well.

We stand at the threshold of a most promising future. Many of the conflicts and all of the controversies of the past have at this meeting been cleared away. To the observing mind, old questions and doubts of hypothesis, theory, technic and instrumentation have been laid bare in the light of proof. What you have seen and heard presented here was selected work, chosen so that something tangible might be taken away with you. The presentations were based on theoretical, experimental and practical proof, tested and checked by leaders in our specialized field of endeavor. Here have been answered, with our most recent knowledge, questions of articulation, of technics, of articulators, and of impression work, and many others.

Who can leave without a better understanding of articulation, whether it should be based on sciolism or on science; of technic, whether it is to be based on artistry or on requirements; of articulators, whether they are to be selected on faith or on facts.

Who can leave without a clearer practical conception of each subject so ably here presented? Many questions have been answered and the mystic veils that enshrouded our work have been blown aside, revealing for the first time clearly defined laws of articulation and a practical conception of balanced occlusion.

DISCUSSION

Robert R. Gillis, Hammond, Ind.: Most patients approaching the edentulous stage do so with an air of either resignation or martyrdom. In those who assume the rôle of martyrs, we endeavor first to instill a more favorable attitude of mind by bringing them to understand that an edentulous mouth is more desirable than the present remnant of Nature's denture and that prosthetic dentures, even though not measuring up to 100 per cent in comparison with natural dentures, will be a great improvement. Arguments to this end may be advanced from the point of view of appearance, utility and health; the last of which is usually the most potent. Our practice being largely general, we often have an opportunity to present our arguments during a period of years and seldom encounter a patient who does not abandon the martyr attitude of mind. In fact, we would hesitate to proceed on a case in which the patient persisted in displaying evidence of feeling abused

or of having something unwillingly inflicted on him. Until a bond of confidence is established, cooperation between patient and dentist cannot be effective, and, without full cooperation little success can be expected. I like to visualize the patient as a person whose journey has been impeded by increasing obstacles, which more and more taxed his power of endurance, and whose path finally led him along a perilous brink of ill-health, where a misguided or poorly executed step plunged him over the cliff, and he fell into the valley of inefficiency. The fall was not fatal, but left him bruised. We had been watching his progress along the road, had warned him of dangers along the way, and saw the precipitous fall. We rush to his aid, and do what we can to set him back on the high road of life. However, we cannot lift him again to the stage of efficiency unless he puts forth every effort to help himself; unless he cooperates. We know several routes that will lead back to the high road, but can direct him and assist him only along the one suitable to his degree of self-help-ability. Hence, the more self effort he commands, the quicker will he be ready to continue his journey alone; so much to instill the idea of cooperation, a necessity. Not so many years ago, we rushed into case construction with little or no preliminary survey or preparation. Today, we find it essential to acquire certain data other than impressions and bites, and in the assembling of this data for future reference and guidance, our patient is given his first opportunity to cooperate. When he has a definite part to perform and does it under our guidance, an interest is created that we can use to our mutual advantage. Explain the purpose of each step and you will be agreeably surprised how easily the patient assumes the rôle of your assistant *pro tem*. Let him exercise his judgment on some points; at least, consult his wishes and ask the opinion of a relative or friend who accompanies him. In the selection of tooth moulds and hues, and in arrangement of the front teeth, we often have a fine opportunity to make concessions diplomatically without in any way lessening the factor of our judgment in the case. When our combined decisions have been recorded in black and white, we are ready to proceed on construction. At no time do we paint a rosy picture of the future of our denture patient. He must not forget that his limitations lie well within the range of the possibilities of natural dentures. Certain discomforts and difficulties will be encountered. These can well be forecast and, if anything, enlarged a bit so that when the patient's denture experience does not quite reach the maximum seriousness promised, he is encouraged to think that he is making splendid progress with his case. Your new automobile has a little sticker pasted on the windshield which warns the driver against speed above 20 miles an hour. So we would tell our new denture patient to go slowly for a period. Warn him not to try to masticate a meal until he can wear his dentures without being conscious that they are in his mouth, perhaps for a month. Of course, none of them obey such instruction; for, in a week or ten days, he will come in with a smile of satisfaction and confess that he overlooked your injunction, tried to eat a little, and surprised himself by succeeding. Is he pleased? Indeed he is. It is *his* success, and sweetened even more by the fact that it came in spite of your warning to the contrary. Then it is time to give him further instructions about mastication—small bites, crisp foods, slow movements, etc. While a careful technic for impressions and tooth arrangement will go far toward avoiding sore spots in the supporting tissues, we are liable to encounter a few sore spots. The patient must understand that any sore spot is a sign calling for your immediate attention. To the ordinary freely cooperating patient, such sore spots mean little; but with the nervously inclined, easily irritated patient, these discomforts are magnified to a large proportion. Make a most diligent effort to relieve such irritation in all cases. The patient's disturbances has a dual aspect—it is both physical and mental. In the nervous patient, the physical disturbance, to which we may give the coefficient of 1, may be inducing a mental disturbance with a coefficient of 5, 10 or 20. By effacing the minor physical disturbance, you can often relieve by the same token a mental trouble many times greater. Never try to relieve sore spots by argument. It won't succeed. Do something. Spot the irritated

field; locate its contacting surface on the denture base, and trim; or locate an offending cusp, and trim; and place a healing medicament on the traumatized tissue. Your patient leaves your office again comfortable and with the knowledge that you have succeeded in bringing him one step nearer to the higher levels of efficiency. Urge him to return at the next sign of discomfort and maintain the idea in fact that you are as anxious for his ultimate success as he himself. The education of the patient should be advanced through every possible chance. Do not limit yourself to his ear as the only avenue of getting your ideas across; use some form of printed matter in which you concisely present your principle points. A number of members of this section have found it advantageous to formulate and print little booklets for this purpose. The patient carries his copy home and there through his eye confirms and refreshes the ideas you have previously poured into his ear. Ideas that enter by way of the eye are grasped twenty times more readily than by way of the ear; hence, the value of the black board and chart for teaching. Have a variety of "samples" of completed work in one of your cabinet drawers which can be shown to and handled by your patient as another means of illustration or comparison with his present case. The average patient does not find it necessary to make many returns. Sometimes, a patient becomes quite dependent on your help; but I am free to confess that the attitude even of those who require the fullest measure of moral support and physical relief is justified; for I am not yet able to supply my patients with 100 per cent dentures. We are far ahead of the position held only a few years ago but find much yet to be desired.

Harry D. Weller, Indianapolis, Ind.: Dr. Duell referred to a statement made by Dr. Gillis; a broad statement but nevertheless a truth, for it is an actual fact that day after day and month after month we have brought before us evidence that the dental profession as a whole is not sufficiently grounded and educated in denture technic. Many dentists have an idea that dentures can be constructed by the short route—simply by taking an impression and the so-called bite, sending this to a laboratory and letting the technicians there do all the guessing; hoping by some miracle to receive by the next mail an efficient masticating apparatus. I heartily agree with Dr. Duell that we should study the anatomy of the parts on which we are to work. We should properly diagnose and classify the existing conditions in each individual case. Dr. Duell has emphasized the fact that much thought should be bestowed on the construction of artificial dentures as far as their appearance is concerned; the selection of teeth to agree in size, shape and color, and their arrangement to suit the age and the temperament of the patient. But suppose we have exercised wonderful judgment in all of the aforesaid steps, are we going to ignore a vital scientific step, that of condylar guidance? Are we going to use an arbitrary system and guess at this and that, or do we intend to follow the patient's habitual jaw movements? Dr. Tench has helped somewhat to settle this question in our minds. I agree with Dr. Duell that "Dr. Tench's paper rightfully sounds the death knell of the arbitrary theory." In my opinion, an adjustable articular, set approximately to that particular patient's condyle registration, so that the artificial teeth, when set up, will function with the habitual jaw movement to which the natural teeth were accustomed, is preferable. I am very glad to hear Dr. Duell state that Mr. Hanau's work, as presented at this meeting, is of outstanding merit, and to make the suggestion that if one wishes to simplify his articulation problems, he should study Mr. Hanau's laws of occlusion. Dr. Duell says, "We now stand at the threshold of a most promising future. Many of the conflicts and all of the controversies of the past have at this meeting been cleared away. Many questions have been answered and the mystic veils that have enshrouded our work have been blown aside, revealing for the first time clearly defined laws of articulation and a practical conception of balanced occlusions." May I ask what "mystic veils have enshrouded our work?" Is it the mysterious condyle path, the mystic curve of Spee or some mystical method of impression taking? Has the spherical theory and the concentric spherical theory been blown aside? Are all arbitrary articulators to be relegated to the junk pile? The old saying is, "An honest

confession is good for the soul," so I wish to confess that for the last four years I have been using for occluding purposes an instrument that has a condylar adjustment. We shall still have conflicts, controversies and discussions. If we were all of the same mind, progress would be retarded. Denture technic has not reached the peak of perfection. There is still room for improvement in articulators. The basic scientific principle and the laws governing occlusion have been before the profession a long time, but the trouble is that too few pay attention to what our leaders are trying to teach us. Quoting Dr. Duell, we have something tangible to work from, so let's put our shoulders to the wheel and get to work, practicing some of the advanced technic presented here.

Chester Miller, Indianapolis, Ind.: From time to time, many valuable contributions have been given the dental profession by men who have kept ahead of the crown. Of these contributions, probably none have been of more importance to full denture prosthetics than the law of the curve of compensation, which is the basis for the Bonwill school of movements. However, Dr. George H. Wilson, in the last edition of his book on dental prosthetics, said that "the plane of compensation is of no practical value unless it is in harmony with the excursions of the condyle." It is agreed by those who have given most thought to the subject that there is a certain definite retrusive movement in the condyle; and various efforts have been made to measure and register this movement. But there is more or less conflict of opinion as to the various movements, curves, arcs and centers of movement connected with the process of mastication. As Dr. Charles A. Furrow of Tulsa, Okla., intimated at the meeting of the American Dental Association two years ago, in discussing Dr. J. W. Needles' essay on "Balanced Occlusion," the thing most needed by the prosthetic dentist has been a technic which would enable him to establish in the mouth the maxillomandibular relations and movements, transfer them to an instrument capable of reproducing these movements and reestablish the correct relations in the mouth without losing any of their detail. With such a technic, we must be able to establish and definitely register the plane of compensation, in harmony with the condyle inclination, on the ground-in wax surfaces of the bite plates and transfer it to an articulator that reproduces the rotary movements of the mandible, including the alternating retrusive and protrusive movements of the condyle. On the articulator, this plane of occlusion must be transferred from these wax surfaces of the bite plates to the ground surfaces of the porcelain teeth of the finished dentures. It is a pleasure to say that such a technic has been perfected, and was presented to the profession about two years ago by Dr. Albert Stanley of Indianapolis. This technic is, I believe, what the late Dr. Wilson predicted when he said "That a new school of dental prosthetics is rapidly forming." And this firmly convinces me that Dr. Stanley is entitled to the honor of having us designate this technic as the "Stanley school of articulation."

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Editorial

TOO MUCH SYSTEM

It is essential to have system in all of our professional activities; in the orderliness of our operations, in the regularity of our appointments, in the arrangement of our instruments, in the consecutive following of our technical procedures, in our keeping of records, in our habits of office management, and in everything pertaining to the conduct of our practice. Without system, we would flounder in a confusion of inefficiency, and fail to accomplish half of our allotted task.

But there is such a thing as too much system. Some men introduce so elaborate a system in their office management and such a maze of mechanical contrivances that it is more trouble to look after the system than it would be to do their work without it. Men are sometimes constrained in their mania for system to put more time and energy on the intricacies of a system than they would employ in doing the actual work in hand.

It is on record in certain commercial institutions that some

of their efficiency experts have nearly ruined the business. Any system which is too involved is a handicap rather than a help, and unless efficiency methods are kept down to the fundamental necessities of aggregate performance, they are likely to interfere with the expeditious completion of the work.

Then again, some systems are so complicated that more effort is necessary to master them than they are worth. Unless a system simplifies performance, it is valueless, and many of the suggested systems are far from simple. The contention may be made that, when a system becomes too complicated, it is no longer a system; but this is hardly true. It is the tendency of some of our slaves of system to evolve a most intricate and comprehensive series of procedures, each one of which is perfectly orderly and consecutive, and which may thus be logically classed under the head of a system, but which, taken in the aggregate, form such an array of hidebound and involved requirements as to be wholly impractical.

While a total lack of system is fatal to the expeditious performance of our daily duties, a system which becomes a slavery is almost as great a detriment.

THE EQUALIZATION BILL

At the last session of the Congress of the United States, a bill known as the "Equalization Bill" and having a direct bearing on the status of the members of our profession who are serving in the Navy was passed. It has the effect of placing the officers of the Navy Dental Corps on an equal footing in matters of rank and promotion with other line officers.

Aside from the advantage which this brings to the dentists in the Navy, it is a recognition of the profession by Congress which must afford satisfaction to everyone who has the interests of dentistry at heart.

Dr. W. L. Darnall, lieutenant commander, U. S. N., writing to Dr. King on this measure says:

The purpose of the equalization bill is to provide (1) that staff corps officers shall have the same promotion, or the same opportunity for promotion, as officers of their own time in the line; (2) that qualified staff corps officers may be advanced at the same time as their qualified contemporaries in the line are promoted; and (3) that this parity of opportunity and penalty shall be maintained from the date of such staff corps officers' entry into the service to the date of separation therefrom.

The several staff corps, all of which are within the scope of the act, are as follows: medical, supply, chaplain, construction, civil engineer and dental. Staff officers, by entering the naval service, necessarily subject themselves to definite limitations and restrictions. Unless their opportunities for promotion are such as to counterbalance these limitations and restrictions, it is not reasonable to expect that the service will attract first-class men.

The proposed bill places all officers of the Navy, whether of line or staff, in promotion status. It abolishes all numbers or percentages in grade or ranks in the staff corps, except in the grade of rear admiral. It does not change the present authorized total allowance of officers in any corps and it should remove the friction and discontent due to inequality of promotion as between various corps and the line.

This act of Congress must be very gratifying to everyone interested in the development and status of the dental profession. It is one more demonstration of the value of dental service as a health measure, and is in line with the tendencies of the present day in our legislative bodies to grant to dentistry the recognition which justly belongs to it. It is not so very long ago that many of our legislators were almost wholly lacking in appreciation of the great service which our profession is capable of rendering to the Army and Navy, as well as to humanity at large; and it is a matter of congratulation to all concerned to note the very decided change of attitude on the part of Congress when any measure affecting the status of dentistry is brought before that body. Where formerly there had been indifference and in some cases even an unveiled contempt, today there is manifest a sympathetic consideration and a willingness to cooperate that is most encouraging.

It now remains for the dental profession to live up to the confidence which is thus reposed in it. Every dentist serving in the Army or Navy should realize his responsibility as a represen-

tative of the profession, and should so deport himself at all times that he will bring nothing but credit to his calling and increase the respect which the Government has shown for the profession.

RELAXATION

It is a great art to be able to relax; in fact, it is more than an art—it is an achievement. The exigencies of our modern life demand that we key ourselves up to the highest pitch of application much of the time in order to keep pace with our daily tasks, and unless we learn to relax at certain periods, it is only a matter of time when the inevitable break comes, and we find ourselves a nervous and physical wreck. To learn to relax is not only common sense: it becomes an essential, if we are to survive the excessive pace of the present age.

Time was when the affairs of men proceeded more leisurely and when the tension was less. If it was not convenient to do a thing today, it appeared only natural that tomorrow would do as well. Now it sometimes seems that everything must be done today, because tomorrow usually brings a new set of duties which are sure to make their insistent demand as soon as tomorrow comes. Under conditions such as these, no human constitution can ever stand up indefinitely without an occasional complete surcease from the intense application. And, for some individuals, this is a hard lesson to learn. It takes resolution and discipline and will power to absolve oneself from the obligations and hidebound habits of work that have grown to be a very part of one's nature; and he is a brave and strong man who can do this successfully. But it must be done, if one is to live out one's allotted destiny, and achieve a full and well rounded life.

DEPARTMENT OF DENTAL HEALTH EDUCATION

SOME CONCLUSIONS CONCERNING THE ETIOLOGY OF DENTAL CARIES*

By R. W. BUNTING, D.D.Sc., Ann Arbor, Michigan

THE study of the causes and nature of dental caries has ever been a matter of supreme interest to the dental profession. Although the consummation of this quest would ultimately eliminate the need of a large part of dental services, still, heedless of any possible untoward consequences for the profession, dentistry has diligently sought for the causes of this great scourge and the means of its prevention. The prevention of dental caries would be a great boon to mankind, for thereby not only would the teeth be preserved from carious defects, but also that great problem of root-end infections would be practically wiped out.

The more we study the problems of dental caries, the less sanguine do we become of developing any method by which dental caries may be entirely controlled among people living under the conditions of so-called civilization. The further we proceed in the problem, the more complicated it becomes, involving as it does factors of heredity, internal secretions as they relate to calcium metabolism, diet and nutrition, habits of life, types of oral infection and probably many other forces which at the present time we do not clearly discern.

In the olden days, dental caries was considered an inflammatory or degenerative process in the substances of the tooth, leading to necrosis. Later, the work of Miller, J. Leon Williams and others established the fact that acid fermentations are associated with the process and that the lesion in the tooth is in reality a disintegration of the tooth substance by localized acids. Although they described with considerable accuracy our present view of the process, the early observers were unable to state why caries should be more prevalent in certain mouths than in others, or to describe the factors that control its occurrence. They recognized that certain acid-forming organisms are associated with the initial and deep lesions, but they were unable to find any specific type common to all.

*The papers of Dr. Bunting, Miss House and Miss Hopkins, together with the paper by Dr. Wandel, which appeared in the June issue of THE JOURNAL, were presented as a symposium, the discussion of which appears on page 1328.

*Read before the Section on Mouth Hygiene and Preventive Dentistry at the Sixty-Seventh Annual Session of the American Dental Association, Louisville, Ky., Sept. 24, 1925.

It remained for the later researches of Kligler,[1] McIntosh, James and Lazarus-Barlow,[2] and Rodriguez,[3] to determine that the bacteria of caries might be classified in not more than three special groups, among which *B. acidophilus* greatly predominates. In our own work,[4] we found *B. acidolphilus* present in every case of beginning caries. When cultured on a glucose medium, these organisms produced acids capable of disintegrating the tooth, with the formation of a cavity within a few days to a few weeks. Moreover, in mouths in which caries was especially active, we found *B. acidolphilus* growing luxuriantly and often in pure cultures. In a great majority of mouths that were free from caries, this organism could not be found, and in those cases in which it was present, it was distributed diffusely and showed no tendency to mass overgrowths characteristic of the susceptible mouths. As a further test of the ability of this organism to produce caries, we have placed cultures of this organism with carbohydrates beneath miniature gold cups, which were fastened to the buccal surfaces of four teeth in the mouths of three individuals. Those cultures and the carbohydrates were replenished each week. In my own mouth, a culture held on a vital tooth produced a whitening of the tooth within from two to three weeks. This went on to a superficial decalcification but the tooth became so painful that the process was carried no further. In another case, a most interesting observation was made. A woman about 30 years of age, who up to this time had little dental caries, carried two such cups with cultures of *B. acidophilus* on the buccal surface of two upper first bicuspids. Although these cultures were carried in exactly the same fashion as the others, and although on testing with the indicators, it was clearly evident that the contents of the cups were highly acid, during a period of three months there was practically no visible change in the surface of the enamel. This most remarkable observation excited our curiosity to a high degree. We have made considerable speculation as to the reasons why these teeth were not affected as were the teeth in the mouths of others, and as yet have found only one conclusion, namely, that the quality of these teeth is such as to resist the amount of acids formed in this fashion for a time at least. If this is true, we may find that various teeth differ widely in their resistance to the initial attack of caries, by virtue of which certain teeth may be less prone to disintegration by acid fermentation, and when caries does occur in them, the process may be much more deliberate in its course. The young woman in question is still carrying these cultures, and at the time of writing, after a period of nearly six months, the teeth show evidences of decalcification at the points of application resembling the initial stage of caries.

On the other hand, the observation that dental caries may be produced in animals normally free from this defect by feeding them an inadequate diet has revived the old nutritional theory of caries, and has turned the attention of many to the constitution of the tooth

1. Kligler: J. Allied Dent. Soc. 10: 141, 282, 445, 1915.

2. McIntosh, James; James, W. W., and Lazarus-Barlow, P.: Brit. Dent. J. 43: 728 (Aug. 1) 1922.

3. Rodriguez, N. I.: Dent. J. 5: 199, 1922.

4. Bunting, P. W. and Palmerlee, Faith: J.A.D.A. 12: 381 (April) 1925.

as a controlling factor in caries. It is true that if the process of dental caries prevails in the mouth, its progress will be much more rapid if the teeth are poorly formed than when they are well formed. If the conditions that make for dental caries are not marked, it is possible that a hard, well-formed tooth may resist successfully the acids formed, while a tooth of poorer quality might succumb to the attack. We may speculate further that the increased susceptibility of teeth to caries during childhood, pregnancy and periods of malnutrition may, in part, be due to a decrease in the natural resistance of the tooth to the acids of localized fermentation. It is apparent that the quality of the tooth is not the only factor which determines dental caries, nor indeed is it the most important; for it is a matter of common observation that, in many mouths, teeth of the poorest quality may go throughout the life of the individual without caries.

According to our present views of the situation, it appears that the most active factor in the problem of dental caries consists in the degree of activity of the acid-forming organisms in the oral flora and the environmental conditions under which they exist. In certain mouths, the oral conditions are such as to favor marked over-growths of *B. acidophilus* and other acid forming organisms, which, if they are confined to the surface of the tooth, strongly favor the production of carious defects. In other mouths, the oral fluids and the symbiotic relationships are not conducive to marked aciduric over-growths, and in such mouths, caries occurs only to a limited degree if at all. From our present view of the situation, therefore, it would appear that the most direct control of dental caries may be found in the reduction of over-growths of aciduric organisms when they are present, and the changing of the oral environment so that it is not so favorable for the propagation of this type of organism. Just how this can be done to the best advantage has not been determined as yet. In our work, we have made use of the dyes, namely, combinations of brilliant green and crystal violet and 1:5,000 solutions of metaphen to reduce all oral bacterial activity, with the hope that, when the symbiotic balance of the oral flora is reestablished, it may not be so distinctly aciduric in type. In this, our procedure is not unlike that employed in the treatment of Vincent's infection. Here, too, for some unknown reason, we find in certain mouths intense over-growths of a particular type of organism. Its specific effect is a proteolytic disturbance of the soft tissues, with the production of an ulcerative stomatitis. We find that, by the use of dyes or other suitable antiseptics, we may reduce the oral bacterial activities and that, when they have been reduced over a period of time, the new flora which is established subsequently will be of a different character and the Vincent's organisms will no longer predominate.

In our attempts to reduce B. *acidophilus* overgrowths in the mouths of persons susceptible to caries, we have found that the behavior of this organism under the dye treatment is quite similar to that of Vincent's organism, and that if we apply the dyes on consecutive days over a period of from a week to ten days and institute good oral hygienic conditions in the mouth, in many instances *B. acidophilus* does not subsequently resume its former activity. We have seen a number of cases of extreme overgrowths that were not

controllable by the ordinary prophylactic measures, but which disappeared after consecutive treatment with the dyes. During a period of observation of more than one year, there was no evidence of their former activity.

No judgment of the efficacy of this particular method of controlling dental caries should be formed until a large number of cases so treated have been kept under observation over a period of several years. All we can say at the present time is that the aciduric bacteria seem to be actively associated with the process of initial caries and that the two dyes above mentioned are specifically antagonistic to these organisms. Therefore, it seems reasonable to us that the antiseptic dyes should be employed for the control of dental caries.

When W. D. Miller first made his memorable researches on dental caries and established the relationship of bacteria to that process, he diligently sought among all the then known antiseptics some medicament that might be used to reduce oral bacterial activity for the prevention of caries. He concluded that none of the antiseptics that were then available could be used in sufficient strengths to accomplish this purpose without harm to the oral tissues. Imagine with what great enthusiasm he would have seized on our modern antiseptic dyes, which are so highly efficient in their germicidal properties, and at the same time are so slightly toxic to the body tissues. I am certain that, were he alive today, he would seek to determine in every way possible to what extent these antiseptic dyes may be useful in the control of dental diseases.

We submit to you those observations concerning the control of dental caries with the hope that many will be induced to employ the method suggested and to report their observations concerning their effectiveness.

SUGGESTED METHODS FOR TEACHING MOUTH HYGIENE AND NUTRITION*

By ROSE E. HOUSE,† D.H., Bridgeport, Connecticut

THE aims of health education, as stated by the joint committee on health problems in education of the National Educational Association and the American Medical Association, with the cooperation of the technical committee of twenty-seven, are briefly stated as follows:

1. To instruct children and youths so that they may conserve and improve their own health.

2. To establish in them the habits and principles of living which throughout their school life, and in later years, will assure that abundant vigor and vitality which provides the basis for the greatest possible happiness and service in personal, family and community life.

3. To influence parents and other

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adults, through the health education program for children, to better habits and attitudes, so that the school may become an effective agency for the promotion of the social aspects of health education in the family and community as well as the school itself.

4. To improve the individual and community life of the future; to insure a better second generation, and still better third generation; a healthier and fitter nation and race.

Foremost in the attainment and keeping of good health is the proper care of the mouth and perfect nutrition.

No less an authority than the late Dr. Emmett Holt says:

> The problem of nutrition is older than the human race. It began when life began upon this planet.
>
> The survival of a species of plants and later of animals was conditioned on their finding proper food and a favorable environment.
>
> Not only the physical development of man but the fate of nations has been in the past in no small degree dependent upon their ability to solve the food question.

And especially is this true in this day of so many refined or denatured foods.

Theresa Dansdill, in her helpful book "Health Training in Schools," says:

> Nutrition involves, besides correct diet,
>
> 1. The formation and practice of habits essential to health.
>
> 2. The acquisition of knowledge necessary to health.
>
> 3. The development of right attitudes and ideals with regard to health, both physical and mental.

With these objectives in mind, let us see how we can best interest the child and help him to form the good habits so necessary in the attainment and keeping of one's self in 100 per cent good health.

What are the points we wish to stress in this important field of mouth hygiene?

1. The importance of maintaining a healthy mouth with a full set of teeth in normal occlusion so that the child may properly masticate and insalivate his food.

2. How to prevent dental decay and diseases of the gums, because of the relationship of these conditions to chronic mouth conditions and systemic diseases.

These facts may be taught by means of class room talks, toothbrush drills, charts, plaster models, songs and dramatizations. Children of the first three grades live largely in the world of make-believe, and this offers a wide field for development.

In lower grades, a daily system of checkup is very helpful, and, if you are trying to establish habits for a lifetime, absolutely necessary. Daily inspections go a long way toward keeping the child up to requirements. When the child knows that the teacher is going to inspect his mouth, he takes much greater pains in brushing his teeth and gums than he would if the teacher only asks, "How many brushed their teeth this morning?" When a teacher cannot take the time to make a daily inspection of each child's mouth, let her select a few each day, and choose the ones to be examined so that the children can have no idea when their turn will come.

Daily chartings of records have proved most helpful, and a gold star placed opposite the names of those who have rated 100 per cent through the

week has proved stimulating. A banner, to be competed for by the different rooms and awarded at the end of the week to the room having the highest percentage of clean mouths, is another help.

When hygienists are in the schools making examinations and marking charts to be sent home to the parents, a small blue seal bearing the motto, "Clean Teeth," or the small gold seal bearing the motto, "Sound Teeth," affixed to the chart is very gratifying to both child and parent.

Children are very fond of drawing colored pictures, or coloring cut-outs, and it is interesting to see how effectively they will illustrate a talk that has been given them. The more concrete a lesson can be made, the easier it is learned. In the grades where modeling is allowed, we find another medium of expression.

The closer the hygienist can keep in touch with the children under her care, the more satisfactory are the results.

In schools having occasional assemblies, letting the room having the highest percentage of children meeting the requirements lead the procession into the assembly hall and back again is considered an honor. I have known a principal in the lower grades to allow the 100 per cent children of the highest ranking room to parade through the other rooms, bearing a banner.

A toothache in the room affords a most valuable opportunity for a lesson.

Lessons on dental decay and malocclusion need blackboard illustrations, or explanatory charts to make the lesson effective. If the teacher is able to draw her illustrations as her talk proceeds, there is no question that her class will be highly interested.

These methods will also apply to her lesson on the necessity for filling the small cavities in the teeth.

As the development of sound teeth and strong bones depends principally on a diet rich in calcium and other mineral salts, we need at the earliest possible time to present the foods rich in these elements to the child in as attractive a manner as possible. Here story telling can be used very effectively, and questions skilfully asked will bring out the desired information.

The stories on milk and eggs are good to begin with. If the child does not like to drink milk, he can be tempted with dishes which are made largely of milk. Tell him his teeth and bones will be stronger, he can play better, have brighter eyes and more color in his cheeks if he will drink 4 glasses of milk a day, or eat dishes made with milk. The subject of eggs can be handled in a similar manner.

All leafy vegetables should be attractively featured. A great many children do not care for spinach or other vegetables of this class. A daily checkup of the children who eat these vegetables and those who do not is valuable. Then, the teacher should work individually with those who do not, urging them to try just a little and eat it before they eat the ones they do like, instead of leaving it to the last as they are apt to do; and soon you will find out that, though they did not care for them in the first place, to please you they have tried to like them and are willing to eat them because they are so good for one.

In the root vegetable family you may have some trouble getting them to eat carrots, but this may be accomplished in a similar way, as may also the talk-

ing of whole grains for breads and cereals, natural sugar instead of refined, and fruits, nuts, honey, etc., instead of candy, cake and other products of refined sugar.

In the lower grades, the mid-morning lunch offers a wonderful opportunity to stress what is best for such a lunch.

In the higher grades, the children may be taught to choose wisely and make well balanced menus for breakfast, dinner, supper and picnics. In the domestic science classes, the pupils may be taught how to prepare and cook these articles of diet so as to conserve the valuable elements contained therein.

Then, too, this teaching can be carried up to the school lunch counters, in an endeavor to see that nothing but nourishing food properly cooked is served. The bakers of your city or town can be persuaded to bake the 100 per cent whole wheat bread, the grocers to carry whole wheat flour, whole corn meal and brown rice.

There are many attractive little plays, dialogs, recitations, rhymes and songs to be had that are very pleasing to the children and help to drive home the truths taught them. Children of the intermediate grades are often clever at making rhymes and dramatizing a story in which they are particularly interested.

For the upper grades, a health club can be very successfully developed.

To these children, stereopticon lectures, motion pictures and class room talks, followed by discussion periods, prove interesting and instructive. Some fine projects can be developed in posters, pageants, and crusades.

Cooperation in the home may be secured through the child, through parent-teacher associations, or through personal contact, which is most valuable.

Illustrated pamphlets on the most important subjects taught give the parents an opportunity to learn what is being taught their child, and saves many misunderstandings.

It is well to have a mouth hygiene day, and urge the parents and general public to attend. The hygienist should give prophylactic treatments to demonstrate to the visitors the method used, give short class room talks on vital subjects in which she desires the parents cooperation, and be ready to answer any questions pertaining to her work.

The children may give a program of recitations, plays and songs, or a pageant, closing with an instructive mouth hygiene motion picture, if possible. An exhibition of posters, clay models, and projects that have been previously worked out may illustrate this work, and a table display of proper foods can be attractively arranged.

One of the most inspiring things to the child is a hygienist or teacher who practices what she teaches and is in 100 per cent good health and able to be in school every day, full of enthusiasm.

The newspapers of your city can be interested in the work, and will be glad to publish some live articles on these subjects, which will give the public the information which is so vital. Occasionally, clever work done by the pupils can be given publicity.

Every invitation that comes to the dentist to present this subject to local organizations should be gladly accepted, for the sooner the public becomes educated on these matters, the more quickly we will get the results that we so much desire.

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FUNDAMENTALS OF NUTRITION AND RESULTS IN RESEARCH*

By MARIEL HOPKINS,† Louisville, Kentucky

JUST what does the term nutrition include? The story of life from a physical standpoint is one of development from the zygote of a fertilized ovum to a full grown organism. In terms of development of a human body, it means an organized growth from a very minute beginning to 150 pounds more or less. From where does all this weight and growth come? There can be but one answer: It comes from food. Food made available, it is true, through the mechanism of a digestive tract; through the proper functioning of internal secreting glands; through the air we breath; through the sunlight with which we come in contact; through inherited traits; through environment which permits of rest and play—but in the final issue, food. This business of building and maintaining a body from food we recognize as the problem of nutrition.

Nutrition has a multiplicity of aspects. We must supply the food material on which to work. It must be made ready for assimilation through digestion. It must be assimilated. Some of it is transferred for the use of the body in the liver. It is carried to the tissues through the blood or lymph streams. It is ultimately utilized for body building or is oxidized for energy or is specialized to control secretion and excretion.

These problems have challenged the best efforts of the physiologist; they are a big concern of the chemist in physiologic, colloidal and organic as well as other fields. The physicist is active. The scientific world is interested. Through their efforts, we are comprehending that we do literally build and maintain human bodies; that mistakes either through lack of available knowledge or wilful neglect are summed up in a defective body at 21 years of age, one that will not last to good old age with full capacity for enjoyment. It is with these fundamentals of nutrition, as given us from the field of research, that this paper has to deal.

MATERIALS FOR GROWTH AND MAINTENANCE

Minerals.—In order of importance in growth and maintenance, minerals must be placed among the first, not because of the gross amount needed but because of their indispensableness. Sherman[1] outlines graphically the way in which the mineral elements exist in the body and take part in its functions as follows:

(1) As bone constituents, giving rigidity and relative permanence to the skeletal tissues.

(2) As essential elements of the organic compounds which are the chief solids of the soft tissues (muscles, blood cells, etc.).

(3) As soluble salts (electrolytes) held in solution in the fluids of the body; giving to

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1. Sherman, H. C.: Chemistry of Food and Nutrition, p. 333.

those fluids their characteristic influence upon the elasticity and irritability of muscle and nerve; supplying material for the acidity and alkalinity of the digestive juices and other secretions; and yet maintaining the neutrality, or slight alkalescence, of the internal fluids as well as their osmotic pressure and solvent power.

This story is told by the calcium, magnesium, sulphur, iron, sodium, potassium, phosphorus and chlorin furnished to the body. Because of their insufficience in the average American dietary, calcium, phosphorus and iron have been the mineral elements of most active concern. For the present discussion, we will narrow these to calcium and phosphorus. Scientists have used three methods of measuring calcium and phosphorus requirements. They have made calcium and phosphorus balance experiments to ascertain how much of the minerals we must supply daily to make up for that lost from the body; they have made growth experiments to determine what the effects of insufficient amounts are, and they have experimented on blood composition.

We are familiar with the following facts, which physiology teaches. About 85 per cent of the mineral matter of the bone consists of calcium phosphate. Phosphorus is an essential part of nucleoproteins (all living cells, particularly nerve tissue). Its compounds function in cell multiplication, in glandular tissue, in sexual elements, in the activation and control of enzyme actions and in the maintenance of neutrality in the body, and exert an influence on the osmotic pressure and surface tension of the body and on the processes of absorption and secretion. Is it any wonder that when we have a disturbance in the metabolism of calcium or phosphorus, we have a disease with divers manifestations such as faulty bone development, delayed and faulty tooth structure and tetany or convulsions as a manifestation of nervous disorder? Such disease we have learned to know as rickets.

Park[2] gives a comprehensive definition: "Rickets is a disturbance in the metabolism of the growing organism of such nature that the salt equilibrium in particular as regards the calcium and phosphorus, in the circulating fluids is disturbed, and lime salts no longer deposit in the bones. Lime salts may not deposit because the *ionized* calcium in the blood is low, or because the *ionized* phosphate is low, or because both are low."

The work of Hess and his co-workers,[3] of McCollum and his co-workers,[4] of the Mellanbys[5] and others has, within

2. Park, E. A.: Etiology of Rickets, Physiol. Rev., 3: 106 (Jan.) 1923.

3. Hess, A. F., and Unger, L. J.: The Diet of the Negro Mother in New York City, J.A.M.A., 70: 900 (March 30) 1918; Hess, A. F., and Weinstock, M.: Rickets as Influenced by Diet of Mother During Pregnancy and Lactation, J.A.M.A., 83: 1558 (Nov. 15) 1924; Hess, A. F., and Unger, L. J.: Infantile Rickets; the Significance of Clinical Radiographic and Chemical Examinations in Its Diagnosis and Incidence, Am. J. Dis. Child., 24: 327 (Oct.) 1922.

4. McCollum, E. V.: Studies on Experimental Rickets. XXI. An Experimental Demonstration of the Existence of a Vitamin which Promotes Calcium Deposition. J. Biol. Chem., 53: 293 (Aug.) 1922; Shipley, P. G.; Kinney, E. M., and McCollum, E. V.: Studies on Experimental Rickets. XXIV. The Effect of Certain Extracts of Plant Tissues on Florid Rickets. J. Biol. Chem., 59: 165 (Feb.) 1924.

5. Mellanby, May: The Effect of Diet on the Structure of Teeth. The Inter-Relationship Between the Calcium and Other Food Factors, Brit. Dent. J., 44: 67 (Sept. 15) 1923.

the past few years, increased knowledge concerning the factors that control rickets.

We know from chemical analysis that cow's milk is a rich source of calcium. Yet Park[2] states that "the fact cannot be forgotten that the great majority of children who develop rickets do so on diets of cow's milk." The direct proof of the curative action of cod-liver oil was first obtained by McCollum, Simmonds, Shipley and Park. They discovered early that cod-liver oil caused remarkable depositions of lime salts to form in the cartilage of the rachitic rat. McCollum, in 1922, presented evidence that coconut oil lacks the power to cure xerophthalmia, but has the power to cause deposition of lime salts in the rachitic skeleton. Hess and others have presented evidence to show the seasonal variation of rickets, and the universality of rickets among infants and children living under conditions that prevail in our large cities. In June, 1919, Park[2] stated that Huldschinsky reported the ultra-violet ray as exerting a curative action.

Thus, rickets is known to be an entity caused by disturbance in calcium or phosphorus balance, one or both. There are apparently two widely different sources for preventing this disturbance. One of these at present varying sources is the direct rays of the sun. The ultraviolet ray, which is filtered out when light is passed through glass, has been found the preventive or curative factor; hence the warning that outdoor rather than indoor sunlight is necessary. The other is the vitamin long confused with the one producing xerophthalmia, and which, as cited above, has been proved distinct. This rickets-preventing vitamin (called D by most authorities) is found, according to Park,[2] in abundance in the oil of the cod and in considerable amounts in the oils of the shark and burbot, a fresh-water fish. It is present in small amounts, as compared with cod-liver oil, in butter fat. Other vegetable oils that have been studied, among which are olive oil, maize oil and linseed oil, appear to be entirely free from it. Thus, we find a real reason for baby's outdoor sun bath, when his body can be exposed to the direct rays, and, when this is impracticable, the substitution of a few drops of cod-liver oil with each feeding answers the purpose in correct body building.

Rickets frequently accompanies infantile scurvy; indeed, Park[2] says that it is exceedingly uncommon to find scurvy uncomplicated by rickets.

Vitamins.—There has been so much talk regarding the rôle of so-called vitamins in nutrition that a general discussion seems superfluous. These elusive entities of diet (elusive because there is still conjecture concerning their nature, though their abundance in definite foods has been well established) have been most sensational factors in experimentation. Through their abundance or lack in animal experimentation, scientists have been able to produce or cure at will deficiency diseases specific for the particular vitamin in question. These we know as: xerophthalmia, a condition profoundly affecting the eyes, which is the A vitamin deficiency disease; polyneuritis or beri-beri, which is the B vitamin deficiency disease; scurvy, which is the C vitamin deficiency disease; rickets, which we have already met as the D vitamin defi-

ciency disease; and finally the vitamin controlling reproduction, called vitamin E.

The symptoms of scurvy are dizziness on suddenly standing; gloom and irritability; proneness to fatigue and loosening of teeth and swelling and recession of gums with a dull local ache in the gums or roots of teeth. Animals fed on a scorbutic diet develop soft gums which bleed easily; the bones of the alveolar process are absorbed; the teeth become very loose, and in some cases there is a copious flow of pus.

TEETH HYPOTHESES

Scurvy.—I am perhaps digressing, but to a layman at least, it seems that the nutritionist and the dentist are at this point on common ground. The close resemblance of the symptoms of scurvy and pyorrhea seem evident. Howe[6] and others, after experimental work on guinea-pigs, have come to the conclusion that this disease is due to the type of diet and to the nutritive condition of the individual. Howe finds that the injection of organisms isolated from pyorrhea pockets into the gums and around the necks of the teeth of normal guinea-pigs has no effect. He also quotes from Noguchi, whose work shows that the micro-organisms isolated by him from cases of pyorrhea will not grow on sound tissue. In human experience, it is well known that pyorrhea follows such nutritional disturbances as diabetes, alcoholism, metallic poisoning and syphilis. Dr. Handley-Read[7] has described several cases of acute pyorrhea which completely cleared up on a diet of raw vegetables, salads, fruits, eggs, and a little milk, with very limited intake of carbohydrates. Thus, the nutritive condition is concluded to be the etiologic factor, the infection being but secondary.

Rickets.—In like manner, we find many reported researches linking rickets with dental caries. Perhaps Shipley, Park, McCollum and Simmonds[8] state this as well as does anyone when they say:

> It is somewhat of a surprise when one has become accustomed to thinking of bone as a fixed tissue to find that, despite its apparent stability, bone is extraordinarily labile, and records readily variation of certain dietary factors from the optimum, and that either the production of osseous tissue (apposition) or its destruction (resorption) may be either accentuated or repressed. . . . It is not surprising to find, since bones and teeth are so similar in composition, that the teeth show records of nutritional defects which so profoundly affect the skeleton. Animals on many of these faulty diets have defects in the teeth and their attaching tissues which are being carefully investigated.

Human experience confirms these statements, for we know that rickets in children is accompanied by a delay in the eruption of the deciduous teeth, and that these teeth show a marked tendency to early caries.

Salivary Stimulants.—Pickerill[9] tells us that the number of persons affected with dental caries who live under uncivilized or natural conditions is com-

6. Howe, P. R.: Pyorrhea, J.N.D.A., 7: 419 (June) 1920.

7. Handley-Read: The Influence of Diet on the Teeth, Brit. M. J., 1: 385, 1921.

8. Shipley, P. G., et al.: Studies on Experimental Rickets. X. Rickets and Rickets-Like Disease Produced in Rats by Deficient Diets, Dent. Cosmos, 64: 265 (March) 1922.

9. Pickerill, H. P.: Prevention of Dental Caries and Oral Sepsis, Being the Cartwright Prize Essay of the Royal College of Surgeons of England for 1906-1910, with Some Additions, London: Bailliere, Tindall and Cox, 1912.

paratively small, varying from 1 to 20.8 per cent, while in civilized modern races the percentage is as high as 98.0; and that the number of teeth affected with caries in each individual is far less in those leading natural lives than in those leading artificial or highly civilized lives, in the former varying from 2 to 7 per cent, while in the latter it has become as high as from 15 to 52 per cent.

He further cites the Maori race, an existing primitive people who until recently have been cannibals, as an example of low incidence of caries, basing his statement upon the research of J. B. Mummery on the skulls of primitive and highly civilized races. He attributes their immunity to the "habitual and constant mastication of salivary stimulants, thus producing a constant flow of alkaline and diastatic saliva." In the light of present research, we cannot help wishing that he had included the fact that these primitive people spent a large part of their time in the open in scant attire. Their bodies were exposed to the direct rays of the sun.

Pickerill has divided foods on the basis of their power to stimulate salivary secretion. He finds that oranges, apples, pineapples, grapes and celery are all powerful excitants of a strong alkaline saliva, and that bread and butter, biscuit, brown bread, cake and meat are feeble excitants.

CONCLUSION

It would seem, in the light of research on the fundamentals of nutrition, that we must agree that teeth are included in the building and maintenance of "the house in which we live." Science points to the fact that the following are necessary: an intake of foods liberal in calcium and phosphorus, and foods liberal in vitamin C content; and a means of fixing calcium and phosphorus as a part of tooth structure.

Popularly speaking, does this not mean liberal amounts of milk (the nation's calcium food), and of vegetables (other than potatoes to emphasize variety) together with fruits, of the right type, and plenty of outdoor sunshine?

Let us couple with these (1) proper nutrition habits for the expectant mother and (2) such habits as absolute regularity of eating, and an abundance of rest, and good wholesome play for children; and, all other things being equal, we have made the nutritional requirements mentioned a natural and plausible thing.

DISCUSSION OF PAPERS OF DRS. WANDEL AND BUNTING, MISS HOUSE AND MISS HOPKINS

R. S. Towne, Bismarck, S. D.: Dental literature, from the earliest time, has concerned itself with the problem of why teeth decay. Dr. Bunting's conclusion that the most direct control of dental caries is found in the "reduction of over-growths of aciduric organisms when they are present and the changing of the oral environment, so that it is not favorable for the propagation of this type of organism" impresses me as presenting the determining factor. The theory that the structure of the tooth in itself is not necessarily a guaranty of its immunity to dental caries is sound. The fact that a child is properly nourished throughout the dental development period, and strong, well-formed teeth are thus assured, does not end our problem. I should like to ask Dr. Bunting to explain the technic of applying antiseptic dyes; also, what effect they have on the tissues of the mouth and the teeth and why the antiseptic effect is prolonged so far beyond the effects of other antiseptics. While I am more and more convinced of the important rôle played by oral environmental conditions,

I am of the opinion that such conditions are to be considered as a local manifestation of an impaired general condition; and judging from our present knowledge, the attainment and maintenance of an optimal system condition is largely a nutritional problem. The more experiences I have in studying and handling dental cases, the easier it is for me to concur with the conclusions of Miss Hopkins' paper. Since the advent of the germ theory of disease, much thought and consideration has been given to the study of bacteriology and the tendency has been to look on and consider all diseases processes only from a bacteriologic standpoint. While the principles of bacteriology are unquestionably sound and stand upon a solid foundation, the problem of immunity presents many interesting angles, one of which is the inherent resistance to disease possessed by the tissue cells. Bacteria pervade all space and are ever present, only awaiting favorable environmental conditions to multiply and, if possible, to assert their supremacy. The foundation of life is the cell, and the welfare of the organism is dependent on the welfare of the individual cell; therefore, it is clear that disturbed cellular function, from whatever cause, predisposes bacterial invasion. Dr. G. V. Black's work on salivary deposits showed clearly that the accumulation of salivary deposits on the teeth "is influenced by the kind of food and the amount which is eaten." This is evidence that the daily food intake is not merely an incidental thing but a dominating factor in cellular function. It is not an easy matter to make a definite study of the influence of food on the progress of dental caries in actual practice because of the time necessary to study the problem properly owing to the slow progress of the disease. However, experience with the treatment of many cases of Vincent's infection and other mouth infections by controlling the food intake, wherein the usual duration of the disease is reduced one-half or more, leads to the conclusion that nutrition is fundamental. Dr. Bunting rightly suggests that the problem is a complicated one, and although our present fund of knowledge may not warrant an overly sanguine attitude in the matter, I am convinced that a high degree of success may be attained by educating the coming generations in the principles of right living and thereby checking this trouble at its source.

The papers of Dr. Wandel and Miss House both show possibilities in the educational field. The clear and comprehensive manner in which Miss House has presented many details of teaching mouth health and nutrition makes her paper of great value as a guide in all branches of dental health education. Her suggestion that the most inspiring thing to the child is a teacher and nurse who practices what she preaches and who is in 100 per cent good health is something that we should all take to heart. Dr. Wandel has given us an excellent picture of what is being done in Iowa under the Sheppard Towner Law. His work is unique in that it includes rural and city groups of both preschool and school age, as well as the mother of the preschool child. The development of such a campaign over a period of years cannot but advance the immediate welfare of the individuals reached, but will yield many valuable data which may be used as an aid in shaping a general policy for future growth in the field of dental health education. Dr. Wandel mentions the need of educating the dental profession in the importance of this work. I agree that dentists require education along these lines, but it has been my observation that a majority of the profession are interested but have been slow to proceed in this work owing to the lack of a definite general policy to follow and to the lack of suitable material for carrying on the work. The establishment of the department of dental health education in the Chicago office under the direction of Miss Schmidt has done much to overcome this difficulty. There is no better or surer way in which to advance the standing of dentistry as a profession than by identifying it with the field of health and in direct proportion to the realization of this fact by the profession will our ambition be realized.

Carlos H. Schott, Cincinnati, Ohio: Until a chair of preventive dentistry and periodontia is established in all dental schools, we will not get very far. The courses should include a sufficient amount of practical training. In our city, the upper classmen have been devoting half-day periods, under proper direction, to prophylactic work in our public and parochial schools. It has been observed that the graduates who have had this training in prophylaxis and preventive work are far better fitted for dental practice. The co-

operation of the school heads will, of course, be of great assistance in the promotion of preventive dentistry. The educational work suggested by Miss House will then be assured. I wish to emphasize one of the points in her paper in regard to the food served in the school lunch room. When we can convince the school heads that the serving of proper foods is necessary for health conditions, we will have accomplished a great deal. Since an excess of carbohydrates seems to be the most potent food element in causing acidity, why not play safe and urge at least a reduction of carbohydrates and, as suggested by Miss Hopkins, an increase in milk, vegetables and fruit consumption? Dr. Bunting's experiments emphasize the fact that resistant tooth structure is to be found where we have a more normal nutrition from the prenatal period throughout childhood and life. The use of dyes as suggested by Dr. Bunting is being tried by other pathologists, who are claiming very satisfactory results, so that we may hope that a real mouth bactericide has been found. I should like to ask Dr. Bunting whether, in producing *B. acidophilus*, he produced it anaerobically or aerobically, as the true *B. acidophilus* is of four types, is a true anaerobe and is found normally in intestinal flora, being frequently given to children in specially prepared milk to change the intestinal flora. Dr. Rockwell and Dr. Weary of the University of Cincinnati, are using gentian violet or methyl violet, a gram-positive solution, in 0.5 per cent alcohol and also from 0.05 to 0.005 in aqueous solutions as a bactericide, and with certain degrees of success. My own experience does not permit me to make any claim from personal observation. We must bear in mind that these dyes cannot be used in conjunction with salt solution as it will cause precipitation. Dr. Wandel's report on the administration of the Sheppard-Towner Act in Iowa shows just what can be accomplished when the work is backed by state and government; indicating the great need in his state; and we know that there is a great need for such service in every other state, and in most states, the work has not been so well organized. As stated before, we must impress the dentists with the importance of this work. In our city, when a child applies to the board of education for a work certificate, that certificate must have the signature of a dentist stating that the mouth is in a clean and healthy condition. His dental work is inspected, and if it is not satisfactory to the inspector, the child must return to the dentist or some other dentist for completed work. This, of course, is of great benefit to the individual and also insures a higher standard of dental service. As Dr. Wandel states, we need the cooperation of all the profession. The promoters of mouth hygiene in this country have so far failed to interest the majority of our profession in this work, and it is my belief that we will not accomplish much until we force our educational and public health heads to consider physical fitness above all other things. If physical fitness is as important as we think it is, it should be compulsory that a child enter school or pass from grade to grade only if physically fit, this fitness including dental health. Then and then only will we convince the dental profession and the layman of the importance of preventive dentistry.

Dr. Wandel (closing): The question was asked as to how funds can be obtained through the Sheppard-Towner Act. Congress, before passing the bill, made a provision that a state receiving the benefit of this act would have to appropriate an equal amount. For instance, Iowa gets in the neighborhood of $25,000 and in turn has to appropriate that amount, and when this is done, it is possible to appoint a council that will map out a program. This program is submitted to Washington, and if alterations are needed, they are suggested. Then the state can proceed to carry out the program.

Miss House (closing): I would like to say that with regard to the importance of caring for the first permanent molar, we have tried in Bridgeport to put that idea over to the child itself. As regards inspection, I like to have it done by the teacher as well as the hygienist if the hygienist is operating in the room that month; but you can't have that every month in the year unless you have more workers than we have. Our teachers have been taught to do that work, and the children never know who will be inspected next. In order that it may not take much time, we do rapid class examination. The children are told to roll down the lower lip so that we can see the gums, as to whether they are hard or soft or are inflamed. Once in a while, we find suppuration. Then the upper gum is inspected.

THE ROLE OF DIET IN LACTATION*

By P. MABEL NELSON†, Ph.D., Ames, Iowa

THAT the infant be supplied with a food nutritionally adequate and quantitatively abundant is of paramount importance; yet but little attention has been paid to the effect which maternal care and food have on the production of human milk, the infant's ideal food. Our present knowledge relating to milk production has been gained largely in the field of animal nutrition, through experiments on laboratory animals and research with dairy cows. Recently, there has been an attempt, through control of dietary and hygienic factors, to advance our knowledge of human milk production and put it on the same scientific basis as milk production in the dairy industry.

The problem of human milk production deserves more consideration by physicians and dietitians than it has heretofore received, as all too often a mother fails to nourish her child because, through ignorance, she has not appreciated the important rôle that diet plays in developing abundant milk secretion, or the fact that it is within her power, by maintaining herself in a state of good nutrition, to bring about a maximum adequate milk yield.

Smith (1916),[1] in a study of the effect of the previous nutrition of the mother on the well-being of the child, states that good nutrition on the part of the mother results in a larger percentage of mothers being able to nourish their young, implying that the state of the mother's nutrition has a definite influence on her ability to nurse her infant. The women designated as being in a state of good nutrition were judged so from their general appearance, weight for height and age, etc.; whether above or below the standard, or within the range adopted as normal.

Dorothy Reed Mendenhall (1924)[2] emphasizes also the dependence of the milk flow on diet during pregnancy as well as on diet during the period of lactation, pointing out that mothers long undernourished show reduction in the quality of the milk produced.

The inherent ability of the organism, animal or human, to produce milk is closely associated with its breed and inheritance, as well as being closely dependent on diet. Marshall (1922),[3] discussing the influence of diet and other factors on the composition and yield of cow's milk, lists the factors which need consideration, then states: "But of all the factors enumerated above, diet is perhaps the most important. The richest and also the most abundant supply of milk is usually yielded when the food supply is liberal."

The best summary of the extent of the influence of the food nutrients on

*Read at the midwinter clinic of the Chicago Dental Society, Jan. 27, 1926.

†In charge of Research of the Foods and Nutrition Department, Home Economics Division, Iowa State College.

1. Smith, G. F. D.: Lancet, 2: 54 (July 8) 1916.

2. Mendenhall, D. R.: J. Home Economics, 16: 570, 1924.

3. Marshall, F. H. A.: The Physiology of Reproduction, New York, Longmans, Green & Co., 1922, p. 596.

the yield and quality, i.e., composition of cow's milk, is given by Meigs (1922).[4] From his survey of the literature, it is evident that the quantity of proteins, fats and carbohydrates fed the cow may influence the total milk yield, while the quality of the protein fed, i.e., its amino-acid makeup, tends to influence the composition of the product as well as the quantity of the yield. The effects of reductions in the mineral intake are less marked and may show up more slowly, animals in good nutrition showing very little change in milk yield over rather long intervals of time and then failing or "breaking" suddenly.

The relationship between milk secretion and the vitamin content of the diet, Meigs summarized by saying that "the evidence so far obtained tends to indicate that changes in the vitamin content of the diet influence directly the *concentration* of *vitamins* in the milk rather than the amount of milk secreted. Whatever influence the vitamins of the food may have on milk yield is probably indirect and therefore more or less delayed."

Reasoning from analogy, then, it seems that the food nutrients of the human diet during lactation will produce changes in composition and yield of milk similar to those observed in the lactating cow.

Proceeding on this hypothesis, Hoobler (1917)[5] made the first extensive studies of the types of diet best suited to optimum milk production in women. When the study was started, it was not uncommon to find the mothers, at the end of three weeks, supplying their babies with too little milk daily and the babies' weight at a standstill. The difficulty frequently arose from insufficient intake of food, the diet of the first two to three weeks being not enough to support an increasing production of milk. He observed, however, that "with some modifications of the diet nearly all the mothers were able to supply all the milk necessary to keep their babies gaining the usual weekly amount." As he says, woman can easily ingest from 2,000 to 2,200 calories daily; whereas, she must work to consume from 2,400 to 2,900 calories in twenty-four hours. On a low calories intake (2,000 calories or less daily) the quantity of the milk may keep up but the quality deteriorates as the reserve of of the mother is used up, and the baby fail to gain in weight.

The diet resulting in maximum milk production and also relished most by the women was one which consisted largely of nut proteins supplemented with vegetable and milk protein. The daily protein intake was from 104 to 68 gm., furnishing 16.75 gm. of nitrogen. Eighty-nine per cent of the protein ingested was absorbed, indicating good utilization of the nut proteins.

The diet next best adapted to milk production was one in which the protein was derived from a mixture of meat, milk and egg proteins, with an added quantity of cereal and vegetable protein composing about one-third of the total available protein. This diet was highly efficacious from the standpoint of the quantity and composition of the milk yielded, and also of protection of the maternal tissues. It supplied approximately 2,927 total calories and 130 gm. of protein or 20.64 gm. nitrogen.

From Hoobler's observations, it is

4. Meigs, E. B.: Physiol. Rev., 2: 208 (April) 1922.

5. Hoobler, B. R.: J.A.M.A., 69: 421, 1917.

evident that a generous mixed diet, supplying nut, milk, meat and egg proteins, supplemented with cereals, vegetables and fruits, is one which results in optimum lactation. It is of no avail to overfeed in the hope of maintaining an increasing milk supply, as Hoobler found from 2,600 to 2,900 calories daily more efficacious than from 3,400 to 3,700 calories.

A more recent study of this type has been reported by Adair (1925).[6] He studied the efficiency of the regular hospital balanced diet, a high protein, a high fat and a high carbohydrate diet for milk production during the first twelve days of lactation. He, too, concluded "that liberal protein feeding is of definite value in securing the maximum milk supply from nursing mothers." In addition, he observed that his high protein diet, which supplied 107 gm. daily, with a caloric intake of from 2,000 to 2,400 calories, was more economical from the standpoint of the mother for milk production than the high carbohydrate or high fat diets. The women consuming the high carbohydrate diet averaged a daily caloric intake of from 2,700 to 3,300 calories; those consuming the high fat diet, from 3,300 to 4,000 calories. Adair states that the high fat and high carbohydrate diets appealed to the patients more than the balanced or high protein diets, and he was not able to state whether the high food intake was due to the fact that they liked the food or was taken to satisfy their protein needs. These women secured about 80 gm. of protein from their protein intake in contrast to about 107 gm. on the high protein diet.

I believe that there is current among the medical profession the opinion that it is undesirable to push high protein feeding, particularly of animal protein, during the early stages of lactation, because of its possible connection with the toxemias of pregnancy; yet both Drs. Hoobler and Adair urge the adoption of a generous protein diet, preferably one having a mixture of nut and animal proteins, rather than one having a predominance of any one protein.

Hartwell (1921-1922),[7] in England, studied the effects of feeding excessive protein to lactating rats, and suggested the hypothesis that an excessive protein intake produced a milk which was "toxic" and therefore detrimental to the young. She has, since modified her hypothesis, stating that if sufficient vitamin B is included in the lactating rat's diet, there are no resultant evil effects on the young. This conclusion is in accord with one that I have reached; i.e., that the protein *per se* is not the cause of the peculiar symptoms observed among the baby rats when their mothers are consuming diets high in protein, but that these symptoms are caused by an absence or lack of vitamin B in the mother's diet, which results in the production of a milk of changed quality; that is, a milk deficient in vitamin B.

The protein content of the diet throughout the period of lactation, then, is largely responsible for the milk yield; hence, the selection of the protein becomes of first importance. The biologic value of a protein depends on its peculiar amino-acid makeup. The amino-acids are liberated from the protein foods by the enzymes during digestion and then are absorbed from the

6. Adair, F. L.: Am. J. Obstet. & Gynec., 9: 1-16 (Jan.) 1925.

7. Hartwell, G. A.: Biochem. J., 15: 140-563, 1921; 16: 78-105, 825, 1922.

intestinal tract into the blood stream. The amino-acids of the blood stream are the precursors of the protein of the milk, and inasmuch as the circulating amino-acid mixture may be changed through diet, and these changes have a marked influence on milk secretion, it is important that the lactating mother make the proper selection of protein foods, choosing proteins that will supply the amino-acids that are essential.

Protein foods are not made up of the same number of amino-acids or of the same concentrations of the various amino-acids, and hence may vary widely in their nutritive or biologic value. This was established by the experimental work of Osborne and Mendel, (1912-1913),[8] who pointed out that the proteins of corn and wheat, i.e., zein and gliadin, when the sole sources of protein (18%) in diets of rats which were adequate and well-balanced as regards all other factors, did not suffice for growth until tryptophan and lysin, the missing amino-acids essential for growth, were provided. A third amino-acid, cystin, is also necessary for growth. It is present relatively abundantly in phaseolin, the protein of the navy bean. Though cooking renders the navy bean more digestible, the cystin is seemingly not available (Jones, 1925).[9] It is the absence of tryptophan and cystin from gelatin which makes gelatin an "incomplete protein." Tryptophan, lysin and cystin must be furnished abundantly for normal growth; hence, the diet must supply proteins which are good sources of these amino-acids. The proteins of wheat, corn and navy beans, i.e., gliadin, zein and phaseolin, spoken of as being nutritionally defective, are the chief proteins of some of our most important foodstuffs, and therefore must be properly supplemented to supply the desired quality of protein in the diet.

Jones (1925)[10] has prepared a table indicating the relative value of some of the common protein foodstuffs as sources of the nutritionally essential amino-

TABLE 1.—SOME COMMON PROTEIN FOODSTUFFS THAT ARE SOURCES OF NUTRITIONALLY ESSENTIAL AMINO-ACIDS

Protein	Tryptophan	Cystin	Lysin
Egg proteins	High	Satisfactory	Satisfactory
Milk proteins	High	Satisfactory	High
Meat proteins	Satisfactory	Satisfactory	High
Spinach proteins	Satisfactory	High	High
Nut proteins	High	High	Satisfactory
Wheat bran proteins	High	High	Satisfactory
Zein (corn)	None	Low	None
Oat proteins	Low	High	Satisfactory
Lentil proteins	Low	Low	Satisfactory
Navy bean proteins	Satisfactory	Low	High
Lima bean proteins	Satisfactory	Low	High
Pea proteins	Satisfactory	Low	Satisfactory
Gliadin (wheat)	Low	Satisfactory	Low
Hordein (barley)	Low	Satisfactory	Low
Gelatin	None	Very low	Satisfactory

8. Osborne, T. B., and Mendel, L. B.: J. Biol. Chem., 13: 233, 1912-1913.

9. Jones, D. B., and Gersdorff, C. E. F.: Am. J. Pub. Health, 15: 953, 1925.

10. Jones, D. B., and Gersdorff, C. E. F.: J. Biol. Chem., 64: 241 (June) 1925.

acids. Note that the proteins of egg, milk, meat, spinach, nuts and wheat bran contain all three of the essential growth promoting amino-acids in either satisfactory amounts or in abundance; whereas the cereal or legume proteins, also gelatin, are low in tryptophan, cystin or lysin, and, in some instances, low in two of the three essential amino-acids.

Dietitians and food specialists are urging the use of the whole grain cereals in breads and cereal preparations because of their greater mineral and vitamin content. Their protein content, which is, in large measure, removed in the removal of the bran (22 per cent in the case of the wheat kernel) adds a large measure of the essential amino-acids, which would otherwise be lost. Wheat bran, according to Jones and Gersdorff (1925),[10] contains from 12 to 17 per cent of protein, calculated on the basis of its nitrogen value, and amino-acids, as follows:

TABLE 2.—SOME AMINO-ACIDS OF THE PROTEINS OF WHEAT BRAN (EXPRESSED AS PERCENTAGE OF THE ASH-FREE AND MOISTURE-FREE PROTEINS)

Amino-Acids	Prolamin Per Cent	Globulin Per Cent	Albumin Per Cent
Cystin	2.29	1.52	3.29
Arginin	4.41	14.13	10.04
Histidin	0.84	2.76	2.57
Lysin	2.45	11.84	4.51
Tyrosin	3.38	3.69	4.20
Tryptophan	1.37	2.85	4.76

Their feeding experiments with white rats in which wheat bran was the sole source of protein indicate that this bran's efficiency in promoting growth is superior to that of the wheat endosperm or the patent wheat flour of commerce. The rats on the wheat bran showed an average gain in weight of 1.81 gm. for every gram of protein consumed; whereas, the rats on the white wheat flour grew at only one-half to two-thirds of this rate. Both diets contained the same percentages of protein nitrogen, equivalent to 9.9 per cent of the crude protein.

Moore (1925) reports a study of the comparative nutritional value of white and whole wheat flour, which adds further confirmation of the superior growth-promoting value of the bran-containing flour to that of the flour with the bran removed. White mice were fed properly balanced, chemically identical diets except for the flour constituent and showed gains in body weight four times greater on the whole wheat flour than on the white flour diet. The addition of the amino-acids of the bran in the whole wheat flour and of vitamin B are probably responsible for the greater growth. White flour contains practically neither vitamin B nor bran.

Unless there is individual inability to handle the cellulose or bran of the whole grain preparations, whole grain foods should occupy a more prominent place in the dietary. Where whole grain preparations are not possible, the prepared cereals (polished rice, patent flour, etc.,) should have their amino-acid deficiencies generously supplemented as previously indicated by using eggs and milk, etc., in the diet.

The following whole grain foods are now found on the market: wheat: whole grain wheat, shredded wheat, cracked wheat and wheat grits; corn: whole grain corn and krumbles; rice: whole grain rice, brown rice and wild rice.

Grain preparations with the outside hull removed are: wheat: grape nuts, puffed wheat, Wheatena, whole wheat flakes and "Sims-Malt of the Wheat";

corn: corn flakes, corn meal and pearled hominy; oats: rolled oats, oat flakes and ready cooked oats; rice: puffed rice; barley: pearled barley.

In addition to providing a protein of high biologic value, the diet of the lactating mother should supply ample sources of the minerals, particularly calcium, phosphorus, iron and iodin, and also vitamins. Relatively small mineral deficiencies of the diet do not influence the milk yield because they are fairly readily supplied from the mother's tissues. The calcium and phosphorus of bone are particularly labile, and are readily available to compensate for minor dietary deficiencies. The softening of the teeth of the pregnant woman is thought to be her response to the demand of the fetus for mineral which she is not furnishing through her food.

Few people realize that the child's temporary teeth are forming about the sixth week of pregnancy (Wandel, 1924) and that they may be very badly formed if the mother herself is in a poor state of nutrition or is negligent of her diet. The permanent teeth form during the last few weeks of pregnancy, and their development makes large demands on the mother. Yet how few mothers pay other than very casual attention to their diet during this extremely critical period. The fetus, during the last two months of pregnancy, is absorbing calcium oxid daily at the rate of 0.638 gm., or an amount equal to the adult's daily calcium requirement. The pregnant woman's calcium need during the last two months is, therefore, twice as great as that of the nonpregnant woman, an intake of from 1.2 to 2 gm. of calcium daily being desirable.

In a review of metabolism in pregnancy, Harding (1925)[11] discusses the extent of the organism's storage of protein, which is presumably laid down as a reserve store to provide for the needs of lactation; also the total balance of phosphorus, sulphur, calcium and magnesium observed by Hoffstrom and Lansberg, large positive gains in these elements made by the mother independently of the fetus again presumably acting as reserve material during the period of lactation. Whether there is or is not such a storage of these important materials preceding lactation is probably a matter of their abundance and availability in the diet previous to the establishment of lactation. If the mammary secretion of optimum quality and quantity is to be maintained, these elements must be supplied in abundance throughout lactation.

A recent survey (Eliot, 1925)[12] of the incidence of rickets in infants in an eastern city revealed that the condition was so prevalent as to be almost universal in all the infants regardless of whether they were breast fed or bottle fed. No attempt was made to increase the concentration of the antirachitic factor (vitamin D) in the mother's milk. Luce (1924)[13] and Steenbock (1924)[14] report an increased content of the antirachitic factor in the milk of cows and goats receiving ultraviolet radiation daily. This suggests the desirability of making a conscientious effort to increase the antirachitic po-

11. Harding, V. J.: Physiol. Rev., 5: 279, 1925.

12. Eliot, M. M.: J.A.M.A., 85: 655 (Aug. 29) 1925.

13. Luce, E. M.: Biochem. J., 18: 1279-88, 1924.

14. Hart, E. B., Steenbock, H., and Elvehjem, C. A.: J. Biol. Chem., 62: 117 (Nov.) 1924.

tency of human milk. If, as generally accepted, the vitamin concentration of milk is a direct reflection of the vitamin store in the diet, this would seem within control of the mother. Foods that will supply a good quality of protein, calcium in generous allowance and the vitamins desired may be had with a little thought given to selection of food materials.

Mendenhall (1924), discussing preventive feeding for mothers and infants, suggests, as a guide in the selection of suitable foods during pregnancy, that certain types of foods be included in the daily menu of the pregnant woman. The daily food needs of the lactating organism are essentially the same as those of the pregnant organism, except that perhaps slightly more food may be required.

TABLE 3.—FOODS ESSENTIAL IN DIET OF PREGNANCY

Kind and Quantity of Food	Energy Supplied Calories	Calcium Supplied Gm.
1 quart of milk	650	0.94
1 egg	70	0.03
1 raw vegetable, such as lettuce, celery or tomato	50	0.05
1 citrus fruit	100	0.1
1 cooked green vegetable	25	0.05 to 0.1
2 slices of entire wheat or graham bread or 1½ ounces of whole grain cereal	150	0.02
	1,045	1.19 to 1.24

The consumption of a quart of milk daily insures the major portion of the calcium needed; and it is fairly easy to obtain the remainder needed from other foods. No equivalent measure of any other calcium-rich food is so readily taken day after day as the the quart of milk. For instance, molasses, cheese, egg yolks, and figs are calcium-rich foods when considered according to their percentage composition of calcium. The quantity which would have to be consumed daily to supply the same weight of calcium obtained through milk would be: molasses, 1½ cups; figs (dried), 1½ pounds; cheese, ¼ pound; egg yolks, fifty.

The eating of a citrus fruit daily is desirable because of the calcium and vitamin C content. It has been shown by Blunt and Chaney,[15] particularly for orange juice, that the daily use of orange juice induces an increased retention of the calcium, phosphorus and magnesium and also the protein of the diet. Therefore, the addition of the juice of an orange daily allows greater economy in the utilization of the mineral content of the food consumed.

The uncooked vegetables such as lettuce, celery, tomato, shredded cabbage and carrot, furnish vitamin and minerals, and help increase the bulk of the diet. The green vegetable will furnish vitamins A and B, iron and the organic nucleus which is necessary along with or in combination with iron to build hemoglobin.

The whole grain cereals and breads as previously stated, furnish desirable amino-acids, and vitamin B. Including one of each of the foods suggested in Mendenhall's plan for the daily menu

15. Blunt and Chaney: J. Biol. Chem. (Dec.) 1925.

will insure a good calcium and high grade protein intake, and at least one-third of the total calories needed by the average normal mother. If in addition one serving of lean meat, and potato, and three servings of butter and cereal or bread are added to these foods, the diet will furnish sufficient calories. If the caloric intake needs curtailing, more fruits and vegetables may be added.

This diet as suggested may or may not contain sufficient iodin, as the iodin content of foods and drinking waters from the different sections of the country vary greatly. The use of an iodized table salt at all times is advisable. Once a week, at least, throughout the year, there should, if possible, be included some sea food such as salt water fish, clams, oysters, Irish moss, sea moss farina, etc., in the diet. The Irish moss is a sea weed gelatin used for making puddings; the sea moss farina, a combination of the sea moss with a finely ground cereal (wheat), also used for puddings. Green leaves contain a fairly high amount of iodin, depending on the regions where grown; hence, watercress grown in streams of iodin-bearing water will be rich in iodin. Spinach leaves, lettuce leaves, chard, kale and watercress are edible green leaves which will help supply iodin. Dr. Oleson (1924),[16] of the United States Public Service, advises that "during pregnancy, iodin should be administered under the direction of the medical attendant, thereby preventing the development of goiter in the child as well as in the mother." Professors Evvard and Culbertson (1925),[17] of Iowa State College, have demonstrated that the addition of from 0.01 to 0.5 per cent of potassium iodid to the basal ration of pigs gave 10 per cent greater gain in weight for the same quantity of food consumed. Probably the same economy in growth will be noted for the human being if iodin is generously supplied.

Carter (1924),[18] of Los Angeles, discussing halogen deficiency, states that "many symptoms exhibited in children, such as malnutrition, retarded or imperfect dentition, rachitis, asthma, etc., etc., may be manifestations of subthyroidism which we are accustomed to so group only if definitely showing retarded mentality or marked degenerative stigmata." Iodin may play a more important rôle than has hitherto been recognized. As with the iodin administration, the time to lay particular stress on the inclusion of calcium, phosphorus, iron and vitamin substances in the diet is during the period of pregnancy, while the fetus is forming. It is desirable, in fact, that these substances be furnished in excess of the demands of the fetus throughout this period, that the body of the mother may be richly stored with them so she may more economically meet the demand put on her in furnishing throughout the period of lactation wholesome milk in abundant quantities.

Since the mineral substances and the vitamins so necessary to the growing organism cannot be elaborated by the mammary tissues, they must come either from the mother's food or her own body tissue. It is poor economy not to

16. Oleson, R.: Pub. Health Rep., 39: 45 (Jan. 11) 1924.

17. Evvard, J. M., and Culbertson, C. C.: Bull. Iowa Ag. Exper. Sta. Res. No. 86. pp. 183-219, 1925.

18. Carter, C. E.: Med. J. & Rec., 120: 174 (Aug. 20) 1924.

give heed to her dietary supply of these essential substances. A good, sound body, with firm bones and well formed sound teeth is an immeasurably valuable heritage to children. The time to begin the production of such bodies and teeth for children is beginning with, even before, the inception of pregnancy, by providing them with mothers who are securing the necessary elements day by day, and who recognize that diet plays the foremost rôle in their development. The mother, by thoughtful selection of her diet during pregnancy and lactation, is laying the foundation for the life long health of the infant and too much stress cannot be given to encouraging future mothers to give heed to their diet during these two most important periods in their lives.

The dental profession has an unlimited opportunity to help in guiding and encouraging better food habits in the people they serve. I am encouraging our young women and young men students, in whom we try to instill sane dietary standards, to work with the dentists and physicians in their community for the furtherance of better health standards for the community.

MOUTH HYGIENE*

By HARRIS R. C. WILSON, D.D.S., Cleveland, Ohio

IN presenting mouth hygiene to the public, one should have a clear understanding of the distinction between mouth hygiene and the practice of dentistry. The latter contemplates diseased conditions and their cure and repair or the restoration of lost dental tissue; while mouth hygiene contemplates the prevention of conditions that require the attention of a dentist.

The practice of mouth hygiene cannot yet be said to be entirely preventive. Our knowledge has not progressed to that extent. We may define the field of mouth hygiene as covering: (1) adequate inspection, (2) the practice of cleanliness, (3) the use of a detergent diet and (4) early conservative, preventive dentistry.

By adequate inspection, we mean the examination of the teeth and adjacent tissues of the mouth, preferably by a dentist; but this may be done by nurses, physicians, dental hygienists or school teachers, or by the mother herself. The inspection should be made at frequent intervals, for diseased conditions of the mouth progress rather rapidly to a serious state. Pain is not manifest until much damage has occurred. Annual examination is not adequate. School inspection, made two or three times a year, is probably all we can expect in the way of inspection on a large scale.

The practice of cleanliness includes teaching the child to clean his teeth himself. The ideal thing is to clean the teeth on arising, after each of the three meals and before retiring; also after eating between meals. However, mouth hygiene does not approve of eating between meals, except in cases in which additional nourishment is required and definite extra meals are provided. We all realize that five or more cleanings a day is more than can be ex-

*Written at the request of the Junior Red Cross for their handbook.

pected under ordinary circumstances. It is common practice to insist on cleaning of the teeth on arising and on retiring at night, the evening cleaning being the more important. The toothbrush should be of appropriate size for the individual. It is rare that too small a brush is used. The tufts of bristles should be well separated on the brush. The texture of the bristles will depend on mouth conditions. A medium bristle should be recommended unless the case is in the hands of a dentist, when the dentist's advice should be secured for that individual case. The dental profession, as a whole, approves the use of tooth pastes and tooth powders, such as are commonly prepared and sold on the market. Individuals will be found who object to the use of the toothbrush, tooth paste and, in fact, almost everything. We all realize that a toothbrush is not an ideal thing, but it is a necessary instrument if we live on cooked foods as most civilized people do. Nurses, teachers and parents will do well to insist that toothbrushes be kept scrupulously clean, preferably hung in the sunshine, exposed to the air. Salt is an acceptable dentifrice and has the advantage of being very inexpensive. Toothbrush drills as given in the schools are of great value as the child is taught the proper method of brushing the teeth as well as being encouraged to form the habit of using the toothbrush. Various methods of cleaning the teeth are advocated by mouth hygiene enthusiasts. The aim of all is to remove the débris, especially from the spaces between the teeth. Whatever method will accomplish this result without doing damage to the soft tissue will be acceptable. The following is a simple formula for brushing the teeth: Brush the upper teeth downward and the lower teeth upward, inside and outside, and scrub the grinding surfaces. After cleansing with the brush, rinse the mouth thoroughly with water. Clean the brush and hang it in the sunshine.

The use of a detergent diet, the third factor in mouth hygiene, is a subject on which volumes may be written. The practical thing that we are teaching is the use of milk, fresh fruits, fresh vegetables, especially leafy vegetables, and whole grains; and less meat, sugar and white flour. The use of foods that clean the teeth by the mechanical act of chewing, such as cabbage, is to be recommended.

The fourth and last item is early conservative preventive dentistry. By early, we mean beginning as soon as teeth are in the mouth. In practice, little work is done for children under 5 years of age; but children should be taken to the dentist much earlier. By conservative, we mean that an effort should be made to retain all the teeth as long as Nature intends that they should be kept in the mouth, provided they are in a state of health. Preventive suggests caring for first permanent molars and temporary teeth so early and in such manner that further decay does not follow our initial procedure. It is generally accepted that cement fillings are short lived and do not offer satisfactory dental service. Metal fillings well made and well finished will answer every requirement.

The service of a dental hygienist is a new idea, which promises to be of increasing value in preserving teeth. The dental hygienist is a person with one or two years of technical training in a dental hygienist school, and licensed to practice dental hygiene by the state. She actually cleans the teeth and teaches the

child the proper home care of the mouth.

The latest development in mouth hygiene is the realization that prenatal attention is absolutely necessary for the development of sound teeth and that normal metabolism must be had throughout infancy and childhood, for we now believe that the good health of the teeth is due to environmental factors. Heredity determines the form, size, and number of teeth; but environment determines the quality of tooth structure and the continuity of development.

TENTATIVE OUTLINE FOR DENTAL ACTIVITIES OF ILLINOIS STATE BOARD OF HEALTH

Following is an outline of the scope of activities of the new superintendent of the Section on Dental Hygiene of the Illinois State Board of Health, H. L. Freidinger, D.D.S., as outlined by Isaac D. Rawlings, M.D., state commissioner of health:

1. Prepare and submit literature for approval by an appropriate committee of the state dental society on the following subjects:
   - (*a*) Tooth formation.
   - (*b*) Dietetics in its important relation to dentistry and health.
   - (*c*) Dental hygiene as related to the expectant mother, this literature to be distributed through the child hygiene division of the state health department, and to be of such nature that dentists and physicians can also distribute it among their private patients.
   - (*d*) Oral hygiene lessons presented in sufficient detail to make them suitable for teaching purposes in the public school.
   - (*e*) Suitable standardized talks, to be given by the "minute men" of the Illinois Dental Society (talks similar to those used by C. Carroll Smith in Peoria, which differ in the different grades).

2. Be responsible for a course of instruction for public health nurses on dental hygiene given by members of the dental society, these lectures to be given before the district sectional meetings of the Illinois Graduate Nurses Association.

3. Work out a standardized illustrated educational lecture service suitable for parent-teacher groups, federated women's clubs and other similar groups.

4. Serve as a court of appeal for local dental societies, public health nurses, women's clubs, parent-teacher groups, etc., wishing consultation or advice in their mouth hygiene programs.

5. Be responsible for a state wide school dental inspection service either carried out by dentists along the lines of that used in Lake County or by public health nurses, with mouth findings recorded on a very simple form as recommended in the Iowa plan, rather than a specific technical dental defects record.

Standardize and make uniform this inspection service by having specific instructions and minimum requirements and record blanks for this work when done by dentists and other specific instructions and minimum requirements when done by others.

6. Be responsible for selection of certain strategic cities which have good medical school inspection, for intensive technical dental service by competent interested dentists, a careful record being made of all defects and an attempt to correlate these in relation to certain nutritional and behavior characteristics or scholastic standing. Put on a drive to have all defects corrected and results studied. Cite the advisory board committee and its program as outlined.

7. Have your representative in the state health department supervise and improve the corrective and reparative dental work now being done and bring in recommendations for extension of this service where needed.

8. Through contact with the dental member of the various Rotary, Kiwanis, Lions and other organizations, get invitations for addresses before these organizations for the "minute men" orators of this society and for yourself.

9. When attempting to sell dental inspection, including reparative dental service, to a board of education and superintendent of schools and they seem almost persuaded, urge the superintendent and president of the board to make a pilgrimage to C. Carroll Smith of Peoria, for an ocular physical convincing demonstration of a successful service.

10. Plan periodic uniform reports from persons carrying on various state dental activities, sufficiently frequent to keep informed as to the progress and success of these dental services.

FIELD NOTES*

Several dentists of Decatur, Ill., recently held an examination of children who are to enter school in September or February, as part of the preschool physical examination campaign sponsored by the state department of health and the federation of women's clubs. The work was carried on in seven school buildings in order to facilitate things for the mothers. Of the children examined, 33 1/3 per cent had cavity-free mouths. In the mouths needing dental treatment, there was an average of five cavities. Records of the general physical examinations and of the dental examinations were kept by the school nurses, who will carry on the necessary followup.

Dr. H. J. Crume, chairman of the Oral Hygiene Committee of the Union County Tuberculosis Association, reports that nine dentists volunteered their services to make a county dental survey. Eighty per cent of the children in the thirteen communities examined had defective teeth. In the school, various projects are being developed to stimulate interest in having the defects remedied. One teacher has her pupils take an imaginary trip to Europe with clean hands and clean teeth as the ticket. Another has a smile contest every morning. Prizes are offered for 100 per cent dental corrections and for 100 per cent tooth brush ownership.

*The Department of Dental Health Education will be glad to receive items of news along the lines of education in dental or general health.

An interesting dental health program is being carried out in Greenville, S. C., with Dr. Walter T. McFall as director of mouth hygiene. The program includes not only corrective work for indigent children, but also a comprehensive educational program in the schools. The charity dental work for one of the large hospitals is carried on as part of the work, as well as a course of instruction to the nurses in training. The director addresses lay groups, such as parent-teacher associations and civic clubs, in order that citizens of the community may have a comprehensive idea of the health work being conducted in their community.

BRIGGS POSTER

A Little Drilling on the Subject of Teeth at Home Will Save a Lot at the Dentist's Office.

WHEN YOU COME TO THE END OF A PERFECT DAY—

CLEAN YOUR TEETH.

This poster, 18x26 inches, is printed in black and red.

Single copies, postpaid	$ .10
10-100 copies, postpaid	.09 each
100 or more copies, postpaid	.08 each

Medical and Dental News

Arkansas

Summer Dental Clinic: The school children of Little Rock received free dental treatment for three months this summer, beginning June 2. Dr. J. T. Starnes of North Little Rock was in charge of the clinic, and the children shown by examination during the school year to be in need of dental care were received at the clinic, which was established by the Little Rock Dental Clinic Association.

California

Dr. Bowers Dentist for Veterans Bureau: Dr. James P. Bowers has been appointed as official dentist for the United States Veterans' Bureau in Monrovia.

Southern California Association Elects Officers: The following were recently elected officers of the Southern California Dental Association: president, G. E. O'Neil, Long Beach; vice president, J. S. Montague, Los Angeles; secretary, J. W. Carson, Los Angeles; treasurer, H. F. Boeckman, Pasadena.

Five-Year Course Adopted: The Board of Trustees of the College of Physicians and Surgeons of San Francisco, School of Dentistry, announce the inauguration of a minimum five-year dental course, commencing Aug. 30, 1926, and leading to the combined degrees of B.S., D.D.S.

Colorado

State Dental Association Elects Officers: The following have been elected as officers of the Colorado State Dental Association: president, C. S. Kramer, Woodman; president elect, W. O. Brubaker; vice president, John Steele; secretary, H. B. Talheim; treasurer, C. H. Peterson; treasurer emeritus, William Smedley; all of Denver. The following were selected for appointment on the state board of examiners: W. W. Coggswell, Colorado Springs; S. M. Gibbs, Fort Collins; Z. T. Roberts, Denver; W. H. Flint, Littleton; Earl W. Spencer, Pueblo.

Illinois

State Dental Society Elects Officers: At the recent meeting of the Illinois State Dental Society, the following were elected officers for the ensuing year: W. F. Whalen, president, Peoria; Thomas L. Grisamore, president elect, Chicago; vice president, Otto H. Seifert, Springfield; secretary, A. C. Converse, Springfield.

Dr. Noyes Becomes Dean: Frederick B. Noyes, director of the children's clinic at the University of Illinois, College of Dentistry, was named dean of the college, at the recent meeting of the university trustees, to succeed F. B. Moorehead.

Clinic Completes Work: The public school dental clinic at Granite City has completed its first year's work. Thirteen dentists contributed their services, and 3,635 pupils were examined, 2,713 of whom were found to have defective teeth.

Cornerstone of New Medical-Dental Center Laid: The cornerstone of the Montgomery Ward Memorial Medical-Dental Center on the McKinlock Campus of Northwestern University was laid, June 11. Addresses were given by Charles H. Mayo, of the class of 1888, on the campus in the afternoon, and by Frank Billings, class of 1881, at a banquet in the evening.

Dental Hall of Fame: In the Montgomery Ward Medical-Dental center, the east half of the main corridor on the tenth floor will be a dental hall of fame, containing, among others, busts of Fouchard, who wrote the first important book on dental practice, in 1728; Chapin A. Harris, who founded the first dental college, 1839; Horace Wells, the discoverer

of nitrous oxid anesthesia; W. D. Miller, who discovered that micro-organisms produce decay of teeth; J. L. Williams, a noted research investigator; William H. Truman, collector of rare books and editor of a dental journal; Eugene S. Talbot, a research worker, and busts of the following founders of Northwestern University Dental School: Drs. G. V. Black, Thomas Y. Gilmer, Edmund Noyes, and Messrs. William V. B. Ames, George H. Cushing, Edgar and Theodore Mengues and C. R. E. Koch, secretaries.

Indiana

Veteran Dentists Honored: G. E. Johnson, of Ft. Wayne, and B. F. Slessman, of Columbia City, each of whom has been engaged in the practice of dentistry for more than fifty years, were honored recently with a banquet at Ft. Wayne, at which about sixty-five dentists from Ft. Wayne and neighboring towns were in attendance.

Minnesota

Northwest District Association Elects Officers: The Northwest District Dental Association of Minnesota recently elected the following officers: president, T. L. Stickney, Crookston; vice president, H. W. Remele, Crookston; secretary-treasuurer, A. C. Gottenburg, Detroit, at the close of a two-day meeting of the association.

Southern Minnesota Association Elects Officers: At the recent annual meeting of the Southern Minnesota Dental Association, the following were elected as officers: president, W. G. Tull, Fairmount; vice president, R. M. Kraft, LeSueur; secretary, M. R. Coulter, Mankato.

Missouri

State Dental Association Elects Officers: At the annual convention of the Missouri Dental Association, the following were elected officers for the ensuing year: president, George B. Winter, St. Louis; president elect, R. J. Rinehart, Kansas City; secretary, H. C. Pollock, St. Louis; treasurer, J. F. McLellan, Moberly. The meeting was held in Jefferson City, with 300 in attendance. St. Louis was chosen as the meeting place for 1927.

Montana

State Association Meets: The Montana State Dental Association held its twenty-third annual convention, June 15-17, at Helena. Billings was selected as the convention city for 1927. The following officers were elected: president, E. J. Crary, Choteau; vice president, J. A. Wright, Havre; secretary-treasurer, J. E. Buehler, Great Falls.

New Jersey

New Members on State Board of Examiners: Roy N. Morrow, Hackensack, and Charles M. Peters, Jersey City, have been appointed to the state board of dental examiners.

Dentist Fined for Practicing Medicine: Bertram Ball, D.D.S., was fined $500, June 4, according to the New York *Times*, for practicing medicine illegally. Dr. Ball's attorney announced that the case would be taken to the U. S. Supreme Court, if necessary, to test the constitutionality of the state law. Dr. Ball is said to have prescribed medicine for the kidneys of a patient he treated for pyorrhea.—*J.A.M.A.*, June 12, 1926.

North Dakota

State Society Elects Officers: The following have been elected officers of the North Dakota Dental Association: president, C. A. Putney, Fargo; vice president, F. J. Hart, Minot; treasurer, R. S. Towne, Bismarck.

Ohio

Dr. Price Honored: A dinner in honor of Dr. W. A. Price was given by The W. D. Miller Club at Cleveland, June 9. Several hundred of Dr. Price's friends joined with the club in paying tribute to the guest of the evening. Many messages of congratulation were received. Dr. Charles H. Mayo of Rochester, Minn., was the speaker of the evening. A loving cup was presented to Dr. Price by The Miller Club.

Oregon

Willamette Valley Association Elects Officers: At a meeting held recently in Albany, the following were elected officers of the Willamette Valley Dental Association: president, S. R. Dipple, Springfield; vice president, R. J. Gunn, Corvallis; secretary-treasurer, W. A. G. Hanford, Corvallis.

Pennsylvania

Dr. Prinz Gets Commission: Dr. Hermann Prinz has been commissioned a lieutenant commander in the Dental Reserve Corps of the United States Navy.

SOUTH CAROLINA

State Association Elects Officers: At the fifty-sixth annual meeting of the South Carolina Dental Association, the following were elected as officers for the ensuing year: president, M. L. Brockington, Florence; first vice president, N. S. Lea, Charleston; second vice president, J. P. Trowbridge, Anderson; recording secretary, T. C. Sparks, Columbia; directing secretary, C. C. Fuller, Greenwood; treasurer, J. A. S. Pike, Columbia.

SOUTH DAKOTA

State Association Elects Officers: The following have been elected officers of the South Dakota State Dental Association: president, Lyle S. Spencer, Watertown; vice president, E. H. Wilson, Miller; secretary, E. W. Elmen, Sioux Falls; treasurer, E. O. Dietrich, Sioux Falls. Drs. Elmen and Dietrich were reelected. The forty-fifth (1927) meeting will be held in Sioux Falls.

State Association Band Organized: The South Dakota State Dental Association Band was organized recently, with a membership of twenty-two. H. C. Henningson of Watertown is president of the organization and Dr. G. Ralph Collins of Vermillion, director. This is believed to be the only band in the United States composed entirely of dentists.

TENNESSEE

State Board Examiners Named: J. A. Gholson, of Clarksville, and H. M. A. Smith of Knoxville were recently reappointed to membership on the Tennessee State Board of Dental Examiners.

TEXAS

New Society Publication Proposed: At the forty-sixth annual convention of the Texas State Dental Society, the question of establishing and maintaining a society publication to take the place of one which is privately owned and published in the interest of the profession was discussed. It was the consensus of those present that the monthly publication should be published by the society and governed by it.

WISCONSIN

Northwest District Society Elects Officers: Following are the recently chosen officers of the Northwest District Dental Society of Wisconsin: president, C. F. Clark, Menomonie; vice president, W. K. English, Glenwood City; secretary-treasurer, A. L. Nelson, Eau Claire (reelected).

Hospital Dental Clinic Opened: Milwaukee's first dental clinic for children was opened recently, at the Milwaukee Children's Hospital. Dr. Lila Frink, formerly of the Forsyth Dental Infirmary, Boston, will have charge of the clinic, and will be assisted by dentists appointed by the Milwaukee County Dental Association, who will give one-half day of their services, each.

State Society Meets: The fifty-sixth annual convention of the Wisconsin State Dental Society was held in Milwaukee, July 13-15. Among the speakers were F. E. Molt, Chicago; E. T. Tinker, Minneapolis; A. R. Barnes, Rochester; G. A. Thompson, Chicago, and L. J. Weinstein, New York City. The following were chosen officers for the ensuing year: president, George Stratton, Oshkosh; first vice president, J. W. Crawford, Milwaukee; second vice president, D. P. Wheeler, Madison; Treasurer, P. A. Howe, Beloit.

WYOMING

State Societies Meet: The state medical and state dental society met in Lander, July 12-13, it being the twenty-fourth annual session of the former society, and the twenty-second of the latter. A joint meeting opened the two conventions, and several other joint meetings were held. At the opening session, Dr. Arthur D. Black, of Chicago, spoke on "Cooperation Between the Physicians and Dentists in the Management of Focal Infections" and Dr. Morris Fishbein, of Chicago, editor of *The Journal of the American Medical Association*, spoke on "Fads and Quackery."

FOREIGN

League for the Promotion of Dental Hygiene: Founded in Turin, last October, with the object of promoting the care and prevention of dental caries, particularly in children, the Lega italiana per la propaganda d'igiena odontoiatrica scolastica has grown rapidly. In the schools, it has introduced a dental record card for the use of physicians entrusted with the medical examinations and to aid in the compilation of eugenic records. The league has induced dealers in school supplies to print maxims of dental hygiene on tablets and composition books, and has had made and distributed a type of toothbrush specially adapted for children. The league has appointed certain Italian stomatologists as its representatives in various provinces. It plans also to commission Drs. Rivano and Maran-

goni to deliver at Turin a series of lectures on the anatomy, physiology and pathology of the dental apparatus, with especial reference to children.—Italian letter, *J.A.M.A.*

General

Drs. Logan and Barrett Honored: W. H. G. Logan, of Chicago, and Thomas J. Barrett, of Worcester, Mass., were recent recipients of the honorary degree of doctor of laws, conferred by Loyola University.

Equalization Bill Passes: The Committee on Legislation (H. M. Spillan, Chairman, H. P. Cobey, C. Williard Camalier and Manly Michaels) announces that H. R. 7181, entitled "A bill to provide for the equalization of promotion of officers of the staff corps of the Navy with officers of the line" has passed the House and Senate and is now ready for the signature of the President.

Southwestern Society of Orthodontists Meets: The sixth annual session of the Southwestern Society of Orthodontists was held at Houston, Texas, August 4-7. "Traumatic Occlusion" was discussed by J. P. Arnold, Houston; "Third Molar Interferences" by P. G. Spencer, Waco, Texas; "Business Side of Orthodontia," by G. L. Turner, Bartlesville, Okla.; "Early Recognition of the Causes of Malocclusion," by W. E. Flesher, Oklahoma City; "Report Covering Craniological Findings from Several Hundred Subjects," by H. B. Robison, Great Bend, Kan.; "The Development of the Face and Jaws," by H. L. D. Kirkham, Houston; and "Rhinology and Its Relation to Orthodontia, by Palmer M. Archer, Houston. Friday, August 6, was taken up with clinics. A golf tournament was held Thursday afternoon, and a theater party completed the entertainment program. After the business session and election of officers, Saturday, August 7, many of the members left by auto or train for Galveston, where they boarded the S. S. *Jacinto*, bound for New York and Philadelphia, to attend the First International Orthodontic Congress and the Seventh International Dental Congress.

Army Dental Corps

Capt. Wayne W. Woolley from duty at Fort Hamilton, N. Y., to West Point, N. Y., Military Academy for duty.

1st Lieut. James M. Epperly to Fort Hamilton, N. Y., for duty.—*Army and Navy Register*, May 29, 1926.

Capt. Howard A. Hale, from duty at Fort MacArthur, Calif.; to Fitzsimons General Hospital, Denver, Colo., for duty.

1st Lieuts. James H. Pence and Mackey J. Real, from duties at Walter Reed General Hospital, Washington, and via transport from New York city about September 8 to Hawaii for duty.—*Army and Navy Register*, June 5, 1926.

Orders of May 20 relieving Capt. Earl F. Long from duties at Ohio State University revoked.

Capt. Avery G. Holmes, relieved from Army Medical School and detailed to office of surgeon general.—*Army and Navy Register*, June 12, 1926.

Maj. Walter S. Smith, ordered before Army retiring board at Fort Sam Houston.

Leave for one month fifteen days granted 1st Lieut. Mackey J. Real, effective July 24.—*Army and Navy Register*, June 26, 1926.

Capt. F. E. Rodriguez, relieved Boston; assigned Army medical school, effective upon relief treatment Walter Reed Hospital.—*Army and Navy Register*, July 17, 1926.

Capt. Wm. F. Scheumann, assigned Fort Hamilton upon completion of tour of foreign service.

Capt. Rufus W. Leigh, relieved Fort McDowell; assigned Hawaiian Dept., sailing from San Francisco about December 8.

Capt. Wm. H. Seifert, relieved Presidio of Monterey; assigned Fort Hancock, N. J., sailing from San Francisco for New York October 23.

Following-named officers relieved Walter Reed Hospital, effective August 23, assigned Army dental school for course of instruction: 1st Lieuts. M. E. Kennebeck and Frank E. Patterson.—*Army and Navy Register*, July 24, 1926.

Deaths

Arnold, Stephen O., St. Paul, Minn.; died, May 16; aged 67.

Bolstad, Fred P., Huntington Park, Calif.; University of Southern California, College of Dentistry, 1909; died, May 21.

Bowers, Frederick H., Freeport, Ill.; Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania, 1894; died, May 11, in Mercy Hospital, Chicago; aged 56.

Brown, Philip Hilbert, Brooklyn, N. Y.; New York College of Dentistry, 1872; died, June 11, after an operation.

Corns, Henry C., Detroit, Mich.; University of Michigan College of Dental Surgery, 1881; died, May 11 from heart disease; aged 65. Dr. Corns retired from practice two years ago.

Courtney, William A., Hancock, Mich.; University of Michigan, College of Dental Surgery, 1886; died, June 13; aged 63.

Fry, Frank W., Brooklyn, N. Y.; College of Dental and Oral Surgery of New York, 1915; died, April 29.

Gans, Melvin B., Cleveland, Ohio; Indiana University School of Dentistry, 1917; died June 17; aged 30. Dr. Gans was a veteran of the World War.

Gurslee, C. Bernard, Granville, Ill.; Northwestern University Dental School, 1918; died suddenly, June 1, from pulmonary hemorrhage; aged 40. Dr. Gurslee moved from Chicago to Granville in October, 1925, in an effort to benefit his health.

Hale, Fred J., Hudson, Mich.; University of Michigan College of Dental Surgery, 1896; died, May 25, after a year's illness; aged 58.

Mahoney, Edward J., Ashland, Wis.; Marquette University, School of Dentistry, 1918; died, May 5, from appendicitis; aged 32.

Monroe, Frank A., Jamestown, N. Y.; Temple University School of Dentistry, 1884; died, May 21.

Onderdonk, Thomas W., Brooklyn, N. Y.; New York College of Dentistry, 1886; committed suicide, May 11, after an illness of several months; aged 64.

Palmer, Edgar, Los Angeles, Calif.; American College of Dental Surgery, 1892; died, May 19; aged 86. Dr. Palmer was a veteran of the Civil War. He retired in 1912.

Phillips, John Alfred, Butte, Mont.; George Washington University, Dental Department, 1907; died, April 22 from influenza; aged 54.

Rand, Percy Leonard, New Bedford, Mass.; Tufts College Dental School, 1899; died, June 14 in Boston; aged 48.

Smith, Frank M., Rushville, Ind.; Indiana University School of Dentistry, 1891; died, June 22, after a brief illness; aged 64.

Sprinkle, James Monticello, Nokomis, Ill.; Indiana University School of Dentistry, 1885; was killed, May 5, when struck by a train.

Szventzell, Raymond A. E., Pittsburgh, Pa.; Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania, 1907; died suddenly, May 5, from heart disease; aged 45.

Templeton, Houston K., Covington, Tenn.; Vanderbilt University, School of Dentistry, 1907; died, May 12, after a brief illness; aged 49.

Umbenhaur, George Walter, Chicago, Ill.; Illinois School of Dentistry, 1899; died, May 22; aged 57.

Worcester, J. Warren, Middletown, N. Y.; died, April 25. Dr. Worcester was also a physician.

CURRENT LITERATURE

EXTRACTS AND ABSTRACTS

Replantation After Severe Injury: Report of a case of successful inplantation of the upper central incisors in a youth of 17 is made by Val. McDonald (*Dent. Sc. J. Australia*, April, 1926). The patient was knocked down by an automobile rim, which blew off while he was putting on a spare tire. One tooth was knocked out, the other driven up into the socket. The former was placed in Ringer's solution, pending replantation, and the operator prepared a modification of a cap splint. Over the position of each incisor, four holes were drilled, so that figure-of-eight lashings might be used to steady the teeth, and the caps were thickened in the bicuspid region to relieve the strain of the bite on the central incisors in order to insure them all the physiologic rest possible. The canals were opened from the lingual surface, and, being rid of pulpal tissue, were washed with hydrogen peroxide, dried, washed with alcohol, dried, and filled with chloropercha and guttapercha points, and finally sealed with cement and a thin layer of amalgam. The tooth that had been driven into the socket was not avulsed until shortly before the operation of replantation. The two sockets were similarly treated. The splint was cemented in position with oxyphosphate of copper cement, and the teeth were placed in position. There was no pain and no rise of temperature. Frequent adjustments were made for one month, at the end of which time the final adjustment was made. The splint was kept on for eight months. Latest reports are that the teeth promise to last many years.

Translucent Zones in Enamel: There has from time to time been some controversy about the meaning of the translucent zones in the dentine, but it is now, we think, very generally accepted that they are some indication of vital reaction on the part of the pulp in caries—they do not occur in dead teeth. These zones in the dentine serve at all events as a temporary barrier to the advance of the micro-organisms of decay; they not only occur in caries but also as a response to irritation from attrition, and they are seen in arrested caries, where they seem to form a more resistant surface to wear. These areas in the dentine stain very imperfectly and in many cases not at all. When the capillary attraction method is used with alcoholic fuchsin (a very penetrating stain), they usually remain quite uncoloured, and there is every reason to believe that there is a deposition of calcific material in and around the tubules in these areas. If such deposition of lime salts can take place in the dentine, it seems highly probable that a similar deposition can occur in the enamel, as the dentinal tubes are in many places, more particularly at the bundles or whorls, so conspicuous at the dentine enamel junction, continuous with tubular spaces in the enamel. It may be objected that clear areas are commonly seen in the enamel, but these are seen to have no relation to caries and may be due to various causes, as differences of thickness, more or less imperfect penetration by clearing agents or areas of more perfect calcification. The coincidence of these clear zones with the carious portion of the enamel and their difference of appearance, extent and situation from other translucent spaces not associated with caries, point to its being a similar condition to that found in the dentine and due to reaction on the part of the pulp. An examination of all the available sections of non-carious enamel shows that there are no translucent areas at the margin of the enamel in the least resembling those seen in carious teeth.—J. Howard Mummery, in *Brit. Dent. J.*

Control of Bleeding in Oral Surgery: Two hundred experimental studies of coagulation and bleeding time were carried out by Leo Winter and Charles G. Darlington (*J. Dent. Res.*, March, 1924-1926), with the following conclusions: Tests are indicated in all operations in which oozing is liable to arise, in-

cluding routine oral work. The injection of epinephrin (a synthetic compound, "suprarenin" was employed) is advocated. Premedication is indicated in cases of prolonged coagulation time or bleeding time. In cases of predisposition to hemorrhage, blood transfusions, roentgen-ray treatment of the bone marrow and, for severe cases, extirpation of the spleen may be considered. Hemorrhage may occur in patients not predisposed to this condition, as in the anemic or the jaundiced. It may be classed as primary, intermediate and secondary, occurring, respectively, at the time of operation, within twenty-four hours, or from one to seven days after operation. Primary hemorrhage is not of serious import. If persistent, pressure is indicated, by means of gauze pads or sponges. Bleeding from the alveolus demands packing with iodoform gauze. Intermediate and secondary bleeding demands heroic measures. Four procedures are indicated: washing, localizing, cleansing and compression. Clots should be eliminated by use of equal parts hydrogen peroxide and water, as hot as can be borne. Bleeding from small vessels in the mucous membrane can be checked by twisting or compression. In capillary bleeding, pressure as in primary hemorrhage should be applied. The following technic is given for bleeding from the alveolus: Procain-epinephrin (suprarenin), 1.5 per cent for the maxilla, 2 for the mandible, is injected, and the socket is cleansed by curetting. Sterile gauze, 2 by 1½ inches, saturated with epinephrin, is inserted in the socket, and, over this, iodoform gauze is packed as firmly as possible. A pad of gauze is put over the socket, upon which there is placed a saddle of modeling compound, and a Barton bandage is applied to maintain the pressure. Space is thus provided on the opposite side for the taking of food. Hemostatics are administered internally, and the patient is directed to avoid all excitement, assume a sitting position during the day and employ a high pillow at night. Food, in the form of fluids, fed through a bent tube, should be taken cold.

Modes of Brushing: We see no objection to people being informed of any new and additional way in which they should brush their teeth; but we object strongly to their being told that there is any way in which teeth should not be brushed. Teeth should be brushed all ways, and the more the better. There is then more chance of their being cleaned. We hear much, and rightly so, of the cleansing effect on the teeth of natural food-stuffs, such as fibrous vegetables and fruit, especially apples. These things do not brush the upper teeth downwards only, and the lower teeth upwards only. If the brushing of the teeth in the way advocated in this lecture were shown magnified in a slow-motion picture, it would be seen that the reflection of the gingival margin is never cleaned at all. As to the groove in the teeth, it is probably the effect of too hard a brush or of an abrasive dentifrice. In any case, as the lesser of two evils, we prefer it to pyorrhea, one of the contributory causes of which is stagnation at the gingival margin.—*Dent. Surgeon.*

Removal of Third Molar, With Fatal Outcome: A case of attempted removal of a partially erupted, semi-impacted lower right third molar, unsuccessful at first, and whose eventual removal was followed shortly by death, is reported by Walter Harrison (*Brit. Dent. J.*, April 1, 1926). The patient, a woman, aged 26, was suffering greatly when she first came in, and there was much swelling on the right side of the mandible. She opened her mouth only with great difficulty and all the soft tissues were badly inflamed. Regional anesthesia was established with difficulty, and as it was impossible to apply forceps along the long axis of the tooth, a straight elevator was employed to dislocate the tooth. A glimpse of the tooth lying in the soft tissues posteriorly to its natural position was had, but it proved impossible to grasp it with any instrument. After many attempts, all trace of it was lost, and it was thought to have been swallowed. After two days, in which the patient suffered great pain, the swelling and pain subsided, there being only some tenderness of the soft palate. The patient and her physician were disinclined to have a radiographic examination, suggested by the dentist, because there was now a total absence of symptoms, local or respiratory. However, a radiogram was made, which proved negative. A second showed the tooth lying with the apices forward along the inner border of the angle of the jaw. This was removed by a surgeon, and the patient made a rapid recovery. She did not return as requested, and on October 25, one month and two weeks after the first attempt to remove the tooth, and nine days after its removal, she had two epileptiform seizures and was removed to a

hospital. Death ensued, November 2, after decompression had been performed to relieve intracranial pressure.

European Dentists in India: Some dentists follow a custom which has obtained for a number of years, that of charging the same fee whatever the work may be. Whether a tooth is extracted, scaled, filled, or merely rubbed to remove tobacco stains, a "flat" rate (usually eight dollars) covers the obligation. The system is manifestly absurd, since it means charging the same fee for an extraction (a matter of five minutes from the time the injection is made till the patient leaves the surgery) as for filling a tooth—an operation which, if much preparation is necessary, may take an hour, and longer. The older men cling to this extraordinary practice, which has been handed down from dentist to dentist during the fleeting years. Their younger confréres generally fix the fee at ten or twelve dollars an hour; but if a patient is known to be none too well off they generously make a reduction. A double plate, half gold and half vulcanite, costs from a hundred to a hundred and fifty dollars, if every tooth has to be replaced, the actual profit being about a hundred per cent.—George Cecil, in *Oral Health*.

Bone Graft of Jaw, Five Years Postoperative: Mr. F., aged 32, an army sergeant, was wounded in the lower jaw and face by a shell fragment in the summer of 1918. This injury and subsequent infection caused a loss of about one and one-half inches of his mandible. I first saw him about one year later and after the construction of a suitable interdental splint for the maintenance of proper dental occlusion, I inserted a bone graft about one and one-half by one-half by three-eighths inches into the defect. The graft was obtained from the left tibia and was secured in place by a silver wire suture at either end. The result is a serviceable jaw and very little deformity. I have done this operation ten times, with seven successes and three failures. The failures seem to be the result of infection. The preparation of the bed for the graft requires care, for the mandibular ends must be perfectly freshened, all scar tissue must be excised and the mucous membrane of the mouth must not be buttonholed.—Jay Dashell Whitman, in *Am. J. Surg.*

Health and Physique of School Children: Bulletin, 1925, No. 21 of the Bureau of Education on Health and Physique of School Children, by James Frederick Rogers, chief of the Division of Physical Education and School Hygiene, is a practical résumé of the progress that has been made in recent years in the care of the health of our school children. Steady progress has been made in safe and healthful housing. The importance of adequate and carefully supervised playgrounds has been recognized, and medical inspection, begun fifty years ago in Europe with the examination of vision, has been extended until now it is almost universal. In line with this has been a steady development of dental work in schools, and efforts at improving nutrition have been begun. Other phases of health progress that are reviewed are the development of open-air schools and open-window rooms, summer camps, special schools and classes, health education, physical training, safety and first aid, pre-school work and teachers' health and training. The parent-teacher organizations also receive their share of mention.—*Boston M. & S. J.*

Maxillary Sinusitis: The need for cooperation between physician and dentist in the handling of dental infection beneath the sinus floor is emphasized by Carl W. Walron (*J.A.M.A.*, Nov. 14, 1925). The anatomy of the maxillary sinus, including gross and microscopic, and all the symptoms of acute inflammation of the sinuses should be well known to both physician and dentist. The etiology of maxillary sinusitis is a matter of extraordinary difference of opinion, since the dentist sees the cases that are apparently of dental origin and the rhinologist sees those associated with nasal obstruction and coryza. Etiologic statistics will be unreliable until the two professions combine to diagnose carefully, treat, follow up and recheck cases. The author says: "The important thing ever to keep in mind is the intimate, anatomic and circulatory relationship of the teeth and investing tissues and the maxillary sinus and the consequent reciprocal relationship of infections in either dental or antral regions."

Seasickness: Seasickness in the healthy adult is usually due to excessive stimulation of the labyrinth. Its effects on the body as a whole are most plausibly explained by radiation of these stimuli from their receptive center in the brain to other associated center, as the vasomotor, respiratory and vabus. There are several other factors that may enter into the problem. These are eye muscle

fatigue, muscle sense disturbance, reflex irritation from the gastro-intesinal tract, and neurotic or physic reactions in certain types of individuals. In treatment, the main reliance is placed on scopolamine and strychnine. In addition, we find useful chorbutanol or some other centrally acting sedative hypnotic. In combating the contributory factors, attention must be given to proper diet and bowel elimination.—P. H. Desnoes, in *J.A.M.A.*

Etiology of Pyorrhea: In support of the theory that pyorrhea is due to a lack of normal stress, which is needed to promote circulation, through proper muscular action, A. N. deGruyther (*Indian Dent. J.*, January, 1926) makes the following points: 1. The masticatory stress grows less in advancing years, so that pyorrhea is common in the aged. 2. As civilization spreads, softer food is introduced and so is the disease. 3. The disease is not seen in the aborigines as their foods are tough and coarse. 4. The disease can be produced in animals by feeding them on a soft diet. 5. Pyorrhea is common in teeth that have no opposing members. 6. Pyorrhea is common in patients who have been kept on a soft diet for a long period.

India's Dental Needs: According to what statistics are available, about 35 to 75 per cent of our school children are suffering from dental troubles; and according to those who are competent enough to speak, as big if not a bigger percentage of India's manhood is also suffering from these troubles; there is a considerable tendency towards the increase of these troubles; and there are no means whatsoever existing to combat the prevalence of this evil. There are only 5,000 dentists (95 per cent of whom are unqualified men) to supply the dental wants of thirty-three crores [crore: 10, 000,000] of India's population; there is not one single dental hospital in the whole of India to give free dental relief to India's poor; and there is not one single full-fledged dental school in the whole of India to give dental education to India's sons. This dismal condition exists in India in the twentieth century . . . . about eighty years after the introduction of medical education.— J. J. Modi, in *Indian Dent. J.*

Foci of Infection and Goiter: Evans regards a deficiency of iodine as only one, although the most important, cause of goiter. In addition, he cites bad teeth, infected tonsils, suppurations in the nose, digestive disturbances, mental shock, and other powerful emotions as responsible factors. In addition to local infections, Pern maintains that a calcium deficiency contributes to thyroid enlargement. Furthermore, in his opinion, goiter is caused by intestinal infection and a fat deficiency. Bran states that focal infections from teeth, tonsils, nasal sinuses, and, more remotely, from gastro-intestinal and genito-urinary affections, are commonly responsible for thyroid enlargement. Other observers, while professing to believe that goiter is caused by foci of infection, are more cautious in expressing their opinions. Brown, for instance, mentions the possibility of a relationship between goiter and tonsillar infections. He inclines to the belief, however, that the tonsil is no more likely to be the focus of infection than any other nidus, e. g., sinuses, teeth, and gall-bladder. Brown urges that throat specialists pay particular attention to the state of the thyroid in all cases of infected tonsils. All who treat thyroid disorders are urged by him to regard infected tonsils as a possible exciting factor. Jackson, basing his conclusions upon an experience with 300 colloid goiters, believes that the removal of septic tonsils proves of some benefit in certain cases. In discussing the indications for tonsillectomy, Greene maintains that the diseased tonsil should be viewed with suspicion in the presence of thyroid enlargement. At the same time, he warns that other foci of infection would not be overlooked. Booth has frequently noted improvement in adolescent goiter after foci of infection have been eliminated. He contends that goiter is the indirect result of focal or general infection rather than the direct result of some specific infection such as may be borne by water. He regards infection of the mouth, sinuses, tonsils, gallbladder or appendix, or the presence of abnormal flora in the intestinal tract, as possible causes of goiter.—Robert Olesen and Neil E. Taylor, in *Pub. Health Rep.*

Ten Commandments of Medical Ethics: 1. Reverence and Responsibility. 2. Historic Appreciation. 3. Keeping the Faith. 4. Inviolable Confidences. 5. The Sanctity of Life. 6. Professional Cooperation. 7. Gentlemanly Conduct. 8. Honesty in Business. 9. Obligation to One's Own. 10. Personal and Public Service.—Frank Wynn.

Announcements

CALENDAR OF MEETINGS*

STATE SOCIETIES

District of Columbia, at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June inclusive.

September (1926)

Delaware, at Wilmington (8).
Maryland, at Cumberland (20-21).

October (1926)

Florida, at Daytona Beach (28-30).
National Capitol, at Washington (5).
Rhode Island, at Providence.

November (1926)

Arizona, at Phoenix.

December (1926)

Nevada, at Reno (4).
Ohio, at Columbus (7).

January (1927)

California, at San Francisco.

February (1927)

Minnesota, at St. Paul (23-25).

March (1927)

Louisiana, at New Orleans.

April (1927)

Alabama, at Montgomery (12-14).
Connecticut, at New London (28-30).
Kansas, at Topeka (18-20).
Kentucky, at Louisville (5-7).
New Jersey, at Newark.

May (1927)

Arkansas, at Hot Springs (9).
Illinois, at Peoria (10-12).
Indiana, at Indianapolis (16-19).
Iowa, at Des Moines (3-5).
Maryland, at Baltimore (2-4).
Massachusetts, at Boston (2-6).
Nebraska, at Omaha (16-19).
New York, at Buffalo (18-20).
Texas, at Austin (10-13).
Vermont, at Burlington.
West Virginia, at Martinsburg (16-18).

June (1927)

Colorado, at Colorado Springs (15-18).
New Mexico, at Roswell.

July (1927)

Porto Rico, at San Juan.
Wisconsin, at Milwaukee (12-14).

*Announcements must be received by the ninth of the month in order to be published in the forthcoming issue of THE JOURNAL.

MEETINGS OF STATE BOARDS OF DENTAL EXAMINERS

Connecticut, at Hartford, November 16-18, 1926. Recorder, A. B. Holmes, Waterbury, Connecticut.

New Jersey, at Trenton, December 6-11, 1926. Secretary, John C. Forsyth, 148 West State Street, Trenton, New Jersey.

North Carolina, at Raleigh, January 10, 1927. Secretary, H. O. Lineberger, Raleigh, North Carolina.

MARYLAND STATE DENTAL ASSOCIATION

The third semi-annual meeting of the Maryland State Dental Association will be held at Cumberland, September 20-21, with headquarters at the Fort Cumberland Hotel. The annual golf tournament will be played

at the Cumberland Country Club on Monday, September 20. Karl P. Heintz, of Cumberland, is chairman of the golf committee. Various entertainments will be provided for visiting ladies. Tuesday morning will be devoted to clinics, and on Tuesday afternoon, there will be a special business meeting. Members of other dental societies will be welcome.

NORVAL H. MCDONALD, *Secretary*,
304 Morris Bldg., Baltimore, Md.

THE CONNECTICUT DENTAL COMMISSION

The Connecticut Dental Commission will meet at Hartford, Nov. 16-18, 1926, to examine applicants for license to practice dentistry and dental hygiene, and to transact any other business proper to come before them. Attention of dental hygienists is called to Chap. 2907, Sec. 11, Amended, of the Connecticut Dental Laws, reading as follows: "From July 1, 1926, every dental hygienist applying for a license shall present a certificate from the state board of education, that she has completed a four years' course at an approved high school, or has an equivalent academic education. No license shall be issued to any dental hygienist unless she shall present a diploma or other certificate of graduation from some reputable institution. The dental commission is authorized to determine the institutions which shall be considered 'reputable institutions' for the purpose of chapter 153 of the general statutes."

For further information, apply to

A. B. HOLMES, *Recorder*,
Waterbury, Conn.

THE STATE BOARD OF REGISTRATION AND EXAMINATION IN DENTISTRY OF NEW JERSEY

The State Board of Registration and Examination in Dentistry of New Jersey will hold its regular examinations at Trenton, commencing Dec. 6, 1926, and continuing for five days thereafter. The license fee is $25; reexamination fee, $10.

Practical tests required: Insertion of an approximal gold filling with the approximating tooth in position, compound approximal amalgam filling and a silicate filling, the candidate to furnish his own patient. Taking of impression, bite, selection of teeth, articulation, trial plate; the candidate to furnish his own patient. Practical examination in mouth diagnosis.

Attention is directed to the following quotation from the dental law of New Jersey: "Applicant shall present to said Board a certificate from the Commissioner of Education of this State, showing that before entering a dental college he or she had obtained an academic education consisting of a four-year course of study in an approved high school or the equivalent thereof."

In accordance with this law, the secretary will issue application blanks only on presentation of the required certificate from the Commissioner of Education, State House, Trenton, New Jersey.

Application must be filed, complete, ten days before the date of the examinations.

Address all communications for further particulars to

JOHN C. FORSYTH, *Secretary*,
148 West State St., Trenton, N. J.

NORTH CAROLINA STATE BOARD OF DENTAL EXAMINERS

The next regular meeting of the North Carolina State Board of Dental Examiners will be held at Raleigh, beginning promptly at 9 o'clock, January 10, 1927. For application blanks and further information, address,

H. O. LINEBERGER, *Secretary*,
Raleigh, N. C.

DINNER IN HONOR OF DR. KELLS

The Odontographic Society of Chicago announces a testimonial dinner to be given in honor of Dr. C. Edmund Kells, of New Orleans, La. Dr. Kells is one of dentistry's most devoted disciples and most active, versatile and beloved representatives. He was the first American dentist to apply the radiogram to the practice of dentistry.

A special literary feature coincident with the dinner will embrace a symposium on "The Dental Hygienist," by Dr. Kells, and Drs. Thomas J. Barrett, of Worcester, Mass., and Alfred C. Fones, of Bridgeport, Conn. The problem of the dental hygienist is one of

the most important issues confronting the dental profession today, and the essayists selected, together with Dr. Kells, are the most brilliant thinkers and writers on this subject at the present time.

The testimonial dinner is a deserving tribute to Dr. Kells, and the literary feature will be an educational treat to all present, and should aid much in solving this problem for the future.

Every ethical dentist throughout the United States and Canada is cordially invited to be present on this occasion.

The dinner and discussion will be held in the Grand Ball Room, Hotel LaSalle, Thursday evening, Oct. 21, 1926, at 6 o'clock. Remember the date, and help to make this occasion a fitting honor to one of dentistry's most active and lovable characters by being present.

DEWITT C. BACON, *President*,
HART J. GOSLEE, *Program Committee*.

NINTH ANNUAL ANNOUNCEMENT OF THE ST. LOUIS STUDY CLUB OF DENTISTRY

This institution will open its 1926-1927 term, Wednesday evening, October 6. Sessions will be held every other week, from 8 to 10 o'clock, in the dental department of the St. Louis and Washington universities, from October to April next.

The St. Louis Study Club, organized in February, 1919, is maintained for the purpose of giving advanced dental courses to ethical dentists, without charge. Its popularity is attested to by its constantly increasing attendance and its support from the members of the profession. The enrollment for the 1925-1926 term was 140.

The only requisites for enrollment are the desire on the part of the dentist to improve his efficiency, and his willingness to complete the technical work in the time prescribed. The plan of the instructor's assigning technical work for each student to complete in his own office and bring to the class session for the constructive criticism of the instructor has proved to be practical in giving the best results with the minimum expenditure of time.

The following are the subjects and instructors for the next term:

Dental ceramics—R. C. Seibert, W. P. Joenk.
Fixed bridgework—G. B. Scott.
Full dentures—B. O. Haun, E. B. Owen.
Dental roentgenology—C. A. LeMaster.
Operative dentistry—J. W. Ford, E. H. Eden.
Dental prophylaxis—William Ernst.
Rizadontia—W. A. Chamberlain, J. A. Walther.
Conduction and local anesthesia—A. C. Engel, W. H. Wells.
Cavity preparation and tooth form—R. C. Wheeler.
Dental Economics—S. H. Voyles, E. E. Haverstick.
Oral diagnosis and diseases of the mouth—Virgil Loeb.

The officers are: W. H. Wells, president; J. W. Ford, vice president; A. T. Gast, secretary-registrar; J. A. Walther, treasurer; H. R. Faherty, historian, and F. C. Rodgers, founder and honorary president.

Bulletins descriptive of the study club can be had by addressing

F. C. RODGERS,
309 Wall Building, St. Louis, Mo.

BOOK REVIEW

Three Score Years and Nine, By C. Edmund Kells, D.D.S., New Orleans, La. With 182 illustrations. Published by the Author, at 1237 Maison Blanche, New Orleans, 1926.

Dr. Kells never wrote a dull or prosaic line in his life. In the two books, "The Dentist's Own Book," previously published, and "Three Score Years and Nine," he has opened his heart to the profession in a very unusual way. These two volumes will stand as the essence of one man's mind during a long and most successful professional career. No other man in the profession could write as does Dr. Kells, no other man could write so entertainingly. In "Three Score Years and Nine," he gathers together many of the papers he has published in periodical literature, thus tracing the evolution of his professional mind from the beginning of his career to its maturity. In addition to this, he frequently makes running comments on current theories and events, and does all of this in the most original and interesting way. He introduces in several instances the work of other writers, but the main portion of the book is wholly his. Dr. Kells seldom does things as others do, and this makes his work all the more alluring. For instance, when he does the unique thing of

writing a review of his own book at the beginning of the volume, he does it in such a manner as to rob it of any apparent unusualness, and at once ushers the reader into the spirit of what he is trying to do. In his own words: "My all absorbing thought is to help the other fellow just a little bit." And this may be said to be the keynote of the life work of "Eddie" Kells.

No one who makes any pretense at keeping abreast of the theory and practice of the day can afford to do without this book. It is more thought-compelling than are most of the volumes offered to the profession, and every dentist should read it.

PATENTS OF INTEREST TO DENTISTS

1476975. Dental matrix clamp, James W. Ivory, Philadelphia, Pa.

1476976. Vibratory controlling device for dental and surgical instruments, James W. Ivory, Philadelphia, Pa.

1477177. Dentifrice, R. A. Knever, Iowa City, Iowa.

1477131. X-ray mount, Irving Kulik, Brooklyn, N. Y.

1477226. Measuring container for dental alloys and the like, Charles W. Meguiar, Sonora, Ky.

1476779. Toothbrush, Herman Taub, New York, N. Y.

1476934. Anaesthetic compound, Ernest H. Volwiler, Chicago, and R. Adams, Urbana, Ill.

1477091. Dental appliance, Harry K. Von der Heydt, Butte, Mont.

63549. Des., Combination soap and toothbrush holder, Stephen D. Baker, New York, N. Y.

1478019. Dental impression guide, Isaac Brown, New York, N. Y.

1477706. Toothbrush and making it, Heinrich Karl, Jersey City, N. J.

1477853. Dental casting apparatus, Walter E. Sattler, New York, N. Y.

1478504. X-ray film holder and examining frame, John A. Adler, North Milwaukee, Wis.

63608. Des., Child's toothbrush, James W. Bevans, Hackensack, N. J.

1478463. Hypnotic and analgesic compound, E. H. Volwiler, Chicago, Ill.

1476103. Hypodermic syringe, Frank L. Platt, G. N. Hein and R. R. Impey, San Francisco, Calif.

1475986. Dental thread holder, Cosby C. Cooke, Logan, W. Va.

1478416. Tongue fastener, L. F. Willett, Evansville, Ind.

1479275. Toothbrush, Henry W. Bell, San Francisco, Calif.

1479364. Dental floss holder, Waldo R. Browne, Wyoming, N. Y.

1479606. Dental handpiece, John R. Impey, San Francisco, Calif.

1479508. Post for artificial teeth, Frederick Maeulen, Rahway, and G. L. Van Allen, Newark, N. J.

1479439. Dental clasp, Reginald V. Williams, Buffalo, N. Y.

1479951. Electric oven for dental purposes, W. A. Bjornstad, and R. A. Silene, Minneapolis, Minn.

1479800. Toothbrush case, Max Feldstein, Chicago, Ill.

1480101. Dental floss appliance, John G. Ogden, Plainfield, N. J.

1479939. Photographic film for X-ray work, Albert F. Sulzer, Rochester, N. Y.

1479946. Denture model former, Coleman B. Warren, Norfolk, Va.

1480814. Toothbrush rack, W. F. Bright and G. Schneider, East St. Louis, Ill.

1480549. Dental stress breaker, Charles J. Emerson, Omaha, Nebr.

1480679. Collapsible toothbrush, James W. Ford, Chicago, Ill.

1481209. Bridge tooth and lock-in backing, A. A. Kaufman, Brooklyn, N. Y.

1480730. Dental shoulder-cutting instrument, John A. Lentz, Phoenix, Ariz.

1481637. Stress-breaking dental attachment, Arthur Feinberg, New York, N. Y.

1481891. Rotary toothbrush, James R. Cruikshank, Vancouver, Canada.

14882027. Toothbrush, William Ochse, San Antonio, Texas.

1481935. Toothbrush container, Daniel S. Terrell, Elkton, Md.

1482741. Dentifrice material, Paul M. Giesy, Plainfield, N. J.

1482993. Dental articulator or relator, Joseph Homer, Boston, Mass.

1483008. Dental handpiece for drills, H. H. Ozanne, Emmetsburg, Iowa.

Copies of the foregoing patents may be obtained for twenty-five cents each, by addressing John A. Saul, Solicitor of Patents, 509 Seventh St., N. W., Washington, D. C.

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